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The Engineer

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PUBLIC NOTICES

ARMY CONTRACTS.

Notice is Hereby Given that TENDERS for QUANTITIES of the undermentioned MANUFACTURED GOODS are invited from time to time, as required :—

METAL TRADES.
Aluminium Ingot, Brass, Brass Rod and Sheet, Bronze Stampings, Copper Ingot and Sheet, Lead, Pig and Sheet, Metal Rod, Nickel, Pig-Iron, Steel Plate, Rounds, Sheets, &c., Shell Steel, Tin Ingot, Tin-plates, Zinc Ingot and Sheets.

Baths, Bicycles, Building Materials and Fitments, Cutlery (including Safety Razors and Blades), Enamelled Ware, Hollowware, Horseshoes, Ironmongery, Machinery Pipes, Steel and Cast Iron, Stable Fitments, Stoves and Ovens, Sanitary Appliances, Tinware, Tools, Vehicles, Wire, Wire Rope.

ELECTRICAL AND SCIENTIFIC INSTRUMENT TRADES.
Cables, Electrical Plant, Electrical and Wireless Stores, Scientific Instruments.

TEXTILE TRADES.
Blankets and Rugs, Braid and Lace Canvas and Canvas Goods, Clothing (made up from Department's own materials), Cotton piece Goods and Cotton Goods, Cordage, Flannel (Union), Headdresses, Horse Rugs, Hosiery, Linen Piece Goods, Silk Cloth and Webbing and Sewing Silk, Towels, Woollen Cloths.

FOODSTUFFS, COAL AND COKE.
OTHER TRADES.
Badges and Buttons, Basket-ware, Bedding, Boots and Shoes, Brooms and Brushes, Chemicals and Gases, China and Earthenware, Furniture, Harness and Saddlery, Leather and Leather Goods, Linoleum, Medical Supplies, Oils and Spirits, Paints and Varnishes, Rubber Boots and Clothing, Timber, Woodware.

Manufacturers who are not already on the War Office List of Tenderers, and who may wish to be invited to Tender for Army requirements of the above Stores, should apply to the Director of Army Contracts at the address given below for Form 1, on which formal application for inclusion on the list of tenderers may be made. The services of an intermediary are unnecessary in approaching the Department for this purpose.

Before being placed on the lists of tenderers, firms will have to satisfy the Department that they actually manufacture goods for which they wish to be noted, and will be required to furnish the names of at least two well-known firms or public bodies who have purchased from them and are in a position to certify as to the quality of their productions. They will further have to give an undertaking that they will comply with the Fair Wages Resolution of the House of Commons.

Attention is called to the following Resolution passed by both Houses of Parliament on 16th February, 1926 :—

"That, in the opinion of this House, it is the duty of the Government in all Government contracts to make provision for the employment to the fullest possible extent of disabled ex-Service men, and to this end to confine such contracts, save in exceptional circumstances, to employers enrolled on the King's National Roll."

SALES.—From time to time the Department has for sale surplus Army Stores of various descriptions, among which may be mentioned Machinery, Steel Girder Bridges, Scrap Metals, Hutting, Motor Vehicles, Drugs, Medical and Dental Stores, Veterinary Stores, Optical and Scientific Instruments, Electrical and Wireless Stores, Clothing, Boots, Textile Goods, Paint.

Firms who wish to be invited to tender for the purchase of surplus stores should apply as directed below.

All applications should be in writing and should be addressed to the Director of Army Contracts, Caxton House (West), Tothill-street, Westminster, London, S.W. 1. No application is necessary from firms whose names are already on the War Office Lists unless they have extended the range of their manufactures.

FRANCIS OSBORN,
4122 Director of Army Contracts.

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/1740.—ASSISTANT HARBOUR ENGINEER REQUIRED by the GOVERNMENT of the GOLD COAST for the Takoradi Harbour, for a tour of 12 to 18 months' service. Salary £480 a year for the first three years of service and then £510, rising to £720 by annual increments of £30 and thence to £920 a year by annual increments of £40. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, age 23 to 35, must have passed "A" and "B" of the examinations to qualify for the A.M.I.C.E. Diploma or hold professional qualifications recognised by the Institution of Civil Engineers as exempting from those examinations. Should have had some civil engineering experience outside pupilage, preferably on harbour and dock works.

M/1940.—ASSISTANT MUNICIPAL ENGINEER REQUIRED by the ACCRA TOWN COUNCIL, GOLD COAST, for two tours of from 12 to 18 months' service, with possible extension. Salary £480 a year for the first three years of service, then £510, rising to £720 by annual increments of £30, and thence rising to £920 a year by annual increments of £40. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, preferably single, 25 to 35 years of age, must have passed Sections "A" and "B" of the examinations to qualify for the A.M.I.C.E. Diploma or hold equivalent qualifications recognised by the Institution of Civil Engineers as exempting from those examinations, or hold the Testamur of the Institution of Municipal and County Engineers. Should have had previous experience as a Borough or Urban Council Engineering Assistant.

M/1807.—CIVIL ENGINEER REQUIRED by the GOVERNMENT of CEYLON for appointment as Irrigation Engineer for three years' service and prospect of permanency. Salary £500, rising to £900 a year by annual increments of £40 (£600 a year on attaining 30 years of age). Free quarters and free passages provided. Candidates, unmarried, 26 to 31 years of age, must have passed examination to qualify for Associate Membership of the Institution of Civil Engineers or hold professional qualifications recognised by the Institution as exempting from Parts "A" and "B" of that examination, and have had at least three years' practical experience on Waterworks, Drainage or Harbour and Dock Works.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 4157

HEATING.

The Commissioners of His Majesty's Works, &c., are PREPARED to RECEIVE TENDERS before 11 a.m. on Tuesday, 28th January, 1930, for REARRANGEMENT of STEAM BOILERS and HEATING at the National Aircraft Factory, Waddon, Croydon.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to The Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 4112

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, REQUIRES TENDERS for :—

SCHEDULE 1. — 25 CRANK and STRAIGHT AXLES for LOCOMOTIVES.
SCHEDULE 2.—758 STEEL TYRES for ROLLING STOCK.
SCHEDULE 3.—WHEELS and AXLES and BOILER PLATES for LOCOMOTIVES.
SCHEDULE 4.—30,000 WOOD SEPARATORS for TRAIN LIGHTING CELLS.

Tenders due as follows :—
Schedules 1, 2 and 3, 21st January, 1930.
Schedule 4, 5th February, 1930.

Forms of Tender available from the above at a fee (which will not be returned) of 5s. for each Schedule. 4169

Chief Mechanical Engineer FOR HOLTON HEATH.
CHIEF MECHANICAL ENGINEER REQUIRED for R.N. Cordite Factory, Holton Heath, near Wareham, Dorset.

Qualifications : Sound knowledge of Mechanical and Electrical Engineering and practical experience in the Upkeep and Working of Factory Machinery, preferably in the Chemical Industry. Ex-Service man preferred. Salary : £400-600, with Civil Service bonus—at present £147 on £400. Apply by letter, giving full particulars of qualifications, diplomas, experience, &c., to the SECRETARY OF THE ADMIRALTY (C.E. Branch), Admiralty, S.W. 1. Appointment would be during the pleasure of the Admiralty, and would be on an unestablished basis and limited to five years in the first instance, with possibility of extension. 4113

Department of Scientific and Industrial Research.

An ENGINEERING ASSISTANT is REQUIRED at the Building Research Station in connection with investigations on Structural Steel Work. Candidates should have practical experience in steel work design and a degree or equivalent qualification. Salary about £300 inclusive per annum, according to qualifications and experience.

Application should be made on a form to be obtained from DIRECTOR, Building Research Station, Garston, Watford, Herts. Forms must be returned not later than Thursday, 23rd January. 4142

Research Department, WOOLWICH.

JUNIOR DRAUGHTSMAN REQUIRED, 21 years of age and upwards, with good general and technical education, experience in Shops, and should have had at least two years on Detailing of Small Machines.

SALARY : From 30s. to 52s. a week (maximum), plus Civil Service bonus, according to age and experience. The total salary, including bonus, at present rates is—minimum 51s., maximum 82s. a week.

Annual leave, 18 days.

Preference given to ex-Service men suitably qualified.

Application to be made by letter, accompanied by copies of not more than three testimonials, to the CHIEF SUPERINTENDENT, Research Department, Woolwich, S.E. 18 4176

The Following Surplus ROLLING STOCK from the Bauchi Light Railway, 2ft. 6in. gauge, all of which is stated to be in very fair condition, is available in Nigeria FOR SALE :—

20 WAGON BOGIES, Diamond-frame type, complete with wheels and axles, 7in. by 3½in. journals.
ONE SPECIE VAN, all-steel, body dimensions 25ft. by 6ft. 4in., with bogies as above.
ONE EXPLOSIVES VAN, similar to Specie Van, but timber lined.
FOUR BRAKE VANS, timber bodies, dimensions same as Specie Van.

Drawings of the above stock can be inspected at the Office of the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, to whom offers for the purchase of the material, either f.o.b. Apapa, Lagos, Nigeria, or c.i.f. an English port, should be submitted, quoting the reference O/Prod. 0618. 4173

PUBLIC NOTICES

Royal Air Force Educational Service.

APPLICATIONS are INVITED for VACANCIES as CIVILIAN EDUCATION OFFICERS in the Royal Air Force Educational Service. Candidates should have a good Degree in Engineering, Physics or Mathematics. Other things being equal, preference will be given to ex-Service candidates and those with previous teaching experience.

The appointments will be made to Grade III., the scale of salary of which is £234-£15-£480, with an allowance varying from £60 to £100 per annum, according to the position on the scale. For entrants with appropriate previous experience commencing salaries up to ten increments above the minimum of the scale may be allowed. Promotion to appointments in higher grades is by selection.

The form of application and a copy of the regulations for the Educational Service may be obtained from the SECRETARY, Air Ministry, Gwydyr House, Whitehall, S.W. 1. Applications should be returned as early as possible. 4168

Armstrong College.
NEWCASTLE-UPON-TYNE.
(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.Sc. and the HONOURS DEGREE of B.Sc. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
3708 Newcastle-upon-Tyne.

University of London.

The Senate invite APPLICATIONS for the UNIVERSITY CHAIR of ELECTRICAL ENGINEERING, tenable at King's College. Salary £1000 a year. Applications (12 copies) must be received not later than first post on 21st February, 1930, by the ACADEMIC REGISTRAR, University of London, S.W. 7, from whom further particulars may be obtained. 4114

In the Matter of LETTERS PATENT Granted to JAMES EDWARD LEA bearing date the 9th May 1914 and numbered 11,459 of 1914 for the INVENTION of "Improvements in and relating to Apparatus for Registering and/or Recording the Amount of Feed of Granular and like Substances."

Notice is Hereby Given that on the 11th February 1930 an ORIGINATING SUMMONS (1929. L. No. 2260) issued out of the High Court of Justice, Chancery Division, on behalf of JAMES EDWARD LEA, and the LEA RECORDER COMPANY LIMITED, asking that the term of the Patent may be extended for a further term of five years will come before Mr. Justice Luxmoore for directions as to the hearing and any person desirous of being heard in opposition must at least 7 days before that date lodge Notice of Opposition (giving an address for service within the United Kingdom) at Room 175, Royal Courts of Justice, Strand, London, and serve a copy thereof upon the undermentioned Solicitor and upon the Solicitor to the Board of Trade.

Dated this 7th day of January, 1930.
GEORGE BELOE ELLIS,
70 and 72, Chancery-lane, London, W.C. 2,
Upon whom all documents requiring service may be served. 4161

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for : PLATE GIRDER BRIDGES (20ft., 40ft. and 60ft. Clear Deck Spans).

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Thursday, 9th January, 1930.

A fee of 10s. will be charged for each copy of the specification, which is not returnable.

Tenders must be submitted not later than Noon on Friday, 17th January, 1930.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
P. W. GIBBS,
4158 Assistant Secretary.

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PUBLIC NOTICES

State Electricity Commission
OF VICTORIA, AUSTRALIA,
22-32, WILLIAM-STREET, MELBOURNE, AUSTRALIA.

TENDERS are hereby INVITED for the SUPPLY and DELIVERY at Yallourn Power Station of REFRACTORY BRICKS for BOILER FURNACES, in accordance with Specification No. 30/7.

Copies of Tender form, specification, &c., will be available upon application to the Agent-General for Victoria, Victoria House, The Strand, London, England.

Charge 5s. for set of two copies complete, returnable under certain conditions as specified in the general conditions of tendering. Extra copies 2s. 6d. each, not returnable.

Tenders, on prescribed form, properly endorsed and addressed and accompanied by a preliminary deposit of £50, must be delivered to the undersigned in Melbourne not later than the 17th February, 1930.

The Commission does not bind itself to accept the lowest or any Tender.

W. J. PRICE,
Secretary.
4069

Slough Urban District Council.
WATER PUMPING PLANT.

The Council invite TENDERS for the INSTALLATION of TWO SETS of MOTOR-DRIVEN CENTRIFUGAL PUMPS to lift water from a 36in. diameter bore-hole to high and low-level reservoirs.

Particulars can be obtained from, and Tenders endorsed "Pumping Plant" should be delivered to the undersigned before Noon on Friday, the 24th January, 1930.

ALAN BROMLY, A.M.I.C.E.,
Water Engineer.
William-street, Slough.
3rd January, 1930. 4097

The Cleansing Committee of
the Manchester Corporation is prepared to receive QUOTATIONS for the SUPPLY of :—

1. ONE CHAFF CUTTING MACHINE (Holt Town Depot). Fitted with sifter and dust extractor, to deal with about 45 cwts. per hour.
2. ONE RIVETING MACHINE (Holt Town Depot). Suitable for riveting together mild steel body sheets of 20s B.W.G. for Ash Bins and riveting top and bottom hoops and handles thereto.
3. ONE PUNCHING AND SHEARING MACHINE (Oldham-road Depot). Motor-driven, single-ended, Punching, Angle and Bar Iron Shearing Machine, to shear Flat Bars ¼in. thick and complete with round and square punches and dies of the following sizes :—3/16in., ¼in., 5/16in., 3/8in., 7/16in., ½in., 5/8in., ¾in., 7/8in., and 1in.
4. ONE COMBINED BOLT and TUBE-SCREWING MACHINE (Oldham-road Depot). One combined Bolt and Tube-screwing Machine Motor-driven, complete with Dieheads, having Tangential Chasers to screw the following Bolts :—3/8in., ½in., 7/16in., ¾in., 9/16in., 5/8in., ¾in., 7/8in., 1in., 1 1/8in., 1¼in., 1½in., and to screw pipes with inside diameters ¼in. up to 3in.

Quotations are to include delivery at the Depots named, and must be sent in before Ten o'clock on Wednesday, the 15th day of January, 1930, addressed to the Director of Public Cleansing, Town Hall, Manchester, from whom further particulars may be obtained upon application.

The Committee does not bind itself to accept the lowest or any quotation.

F. E. WARBRECK HOWELL,
Town Clerk.
4129

Belfast Harbour.
The Belfast Harbour Commissioners REQUIRE the SERVICES of a fully qualified MECHANICAL ENGINEER to act as an Assistant in their Engineering Department.

Applicants must not be more than 40 years of age and, in addition to the usual workshops training and experience, must have received a sound technical education at an Engineering School or College and also have a practical knowledge of the construction and repair of Pumping Machinery, Steam and Electric Cranes, Electric Lighting Installations and Dredging Plant.

Preference will be given to a man who is a Corporate Member of the Institution of Mechanical Engineers or who holds a recognised Degree in Engineering.

The candidate appointed to the position will be required to devote his whole time to the service.

Applications, giving particulars of age, experience and training, accompanied by not more than three copies of recent testimonials, and stating salary expected, must be sent in on or before Saturday, the 25th day of January, 1930, addressed to the undersigned and endorsed "Mechanical Engineer."

M. J. WATKINS,
General Manager and Secretary.
Harbour Office, Belfast.
1st January, 1930. 4141

City of Leicester.
SUPERINTENDENT—SEWAGE PUMPING STATION.

APPLICATIONS are INVITED for the APPOINTMENT of SUPERINTENDENT at the Abbey (main) Sewage Pumping Station, Corporation-road, to Take Control of the Staff, the Supervision of the New Detritus and Storm Water Tanks, also the Steam and Electrical Plant, which includes Four 200 H.P. Beam Engines and Pumps, Eight Boilers, Electrically-driven Triple-ram Pumps, Duplex Sludge Pumps and Screens.

Age limit 30 to 45 years.

Commencing salary £350 per annum (inclusive), rising by £20 to £450 per annum, Grade "F." The Superintendent will be required to reside in house adjoining the Pumping Station and pay such rental as may be arranged on appointment.

The appointment will be subject to the Local Government and other Officers' Superannuation Act, 1922, and the successful candidate will be required to pass a medical examination.

Applications, on forms which may be obtained from the undersigned, accompanied by copies of three testimonials of recent date, must be delivered not later than Saturday, January 18th, 1930.

Canvassing will disqualify.

A. T. GOOSEMAN, M. Inst. C.E.,
City Engineer and Surveyor.
Town Hall, Leicester,
December 30th, 1929. 4079

Doncaster District Drainage
BOARD.
APPOINTMENT OF ENGINEER.

APPLICATIONS are INVITED for the POSITION of ENGINEER to the Board from Engineers having land drainage experience.

The salary offered is £800 per annum. Office accommodation and staff will be provided by the Board.

Particulars of the duties may be obtained upon application to the undersigned.

Applications, endorsed "Engineer," stating qualifications and accompanied by not more than three recent testimonials, must be received by the undersigned not later than the first post on the 17th January, 1930.

Canvassing will be a disqualification.

W. BAGSHAW,
Acting Clerk to the Board.
Town Clerk's Office, Doncaster. 4086

Engineer (Assistant) Re-
QUIRED. Must be skilled Mechanic and Electrician, with knowledge of Maintenance of Plant, Engines, Boilers, Pumps, Electric Lighting Installations, Wiring, Pipe Work, &c.

Candidates should not exceed 35 years of age, and must have had a sound technical training.

Preference will be given to applicant with previous Institution experience.

Wages £4 a week, with possibility of promotion to Chief Engineer in the near future.

Apply, with testimonials, giving age, qualifications and experience, to the MEDICAL SUPERINTENDENT, St. Andrew's Hospital for Mental Diseases, Northampton. 4120

PUBLIC NOTICES

South Staffordshire Water-
WORKS COMPANY.
MECHANICAL DEPARTMENT.

APPLICATIONS are INVITED for the APPOINTMENT of SECOND MECHANICAL ENGINEERING ASSISTANT.

Candidates must be good draughtsmen and have had considerable experience in the design and construction of large pumping units, including steam and Diesel oil-driven plants; also in the maintenance and upkeep of all classes of machinery appertaining to a large waterworks undertaking.

Commencing salary £350 per annum, which is subject to deductions under the Company's Superannuation Scheme.

Applications, stating age, details of education, training, qualifications and experience, accompanied by copies of recent testimonials, must be addressed and delivered to the undersigned not later than Wednesday, the 15th January, 1930.

FRED. J. DIXON, M. Inst. C.E.,
Engineer-in-Chief.
23rd December, 1929.
Engineer's Office,
26A, Paradise-street Birmingham. 4066

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

BOX No. 3880, ACCUMULATOR SALES ENGINEER.—The ADVERTISERS of this POSITION wish to INFORM APPLICANTS that the POSITION is now FILLED. 4156 A

WANTED for Abroad, a Young ENGINEER, with good steam experience; must be single, one possessed of some technical knowledge will have preference.—Reply, Box 1006, Owen's Advertising Agency, 133/6, High Holborn, W.C. 1. 4154 A

WANTED for Abroad, Young MECHANIC, Accustomed to Tin Can Making by modern machinery. One with some electrical knowledge preferred. Must be single.—Reply, Box 1010, Owen's Advertising Agency, 133/6, High Holborn, W.C. 1. 4156 A

WANTED, GENERAL MANAGER for Large Engineering Works in the Midlands (ELECTRICAL and MECHANICAL); must be a good Organiser and experienced in controlling the Commercial, Technical, and Engineering Staff. State age, salary required, experience, &c.—Address, 4172, The Engineer Office. 4172 A

WANTED, Near London, SEVERAL GOOD WELDERS for Welding Joints on Large and Small Steel Tubes. Only skilled and first-class men with good experience of welding joints in trenches, &c., need apply.—Apply in writing only, stating age and experience, with copies of testimonials, &c., to WILLIAM PRESS and SON, Contractors, 38, Old Queen-street, Westminster, S.W. 1. 4042 A

WANTED, Young ENGINEER, Experienced in the driving of "Universal" Joist Piling, to proceed to India for about six months to take charge of piling work and the construction of a small dry dock. State experience and salary required.—Address, 4143, The Engineer Office. 4143 A

A LONDON FIRM, Makers of Recording Instruments for Boiler-house and Works Control, WANT TECHNICAL ASSISTANT, B.Sc. Engineering or B.Sc. Physics or equivalent Degree, with experience in Steam, Gas, Air and Liquid Flow Measurements and Meters. State age, qualifications, and experience in detail, also salary required.—Address, 4151, The Engineer Office. 4151 A

A LONDON FIRM, Makers of Recording Instruments for Boiler-house and Works Control, WANT TECHNICAL SALES CORRESPONDENT, must have adequate technical qualifications and experience in dealing with sales correspondence. State age, qualifications and experience in detail, also salary required.—Address, 4152, The Engineer Office. 4152 A

COMPETENT and Experienced ASSISTANT to HEAD BUYER of Firm of Electrical and Wireless Engineers REQUIRED.—Address, stating age, experience, and salary required, 4132, The Engineer Office. 4132 A

CONSTRUCTIONAL ENGINEERS in London REQUIRE competent STEELWORK DESIGNER. Previous experience in Steel-framed Buildings and Theatres absolutely essential; also must be conversant with L.C.C. requirements. Full particulars.—Address, 4175, The Engineer Office. 4175 A

ENGINEER ASSISTANT WANTED for a Tea Garden in Northern India. Must be educated at a public school, single, between 21 and 25, and fully qualified mechanical engineer with experience of I.C. Engines and Electricity. Salary, Rupees 350 per mensem, and first-class passage.—Write, with full particulars, to "C. X.," c/o J. W. Vickers and Co., Ltd., 24, Austin Friars, E.C. 2. 4123 A

ENGINEER REQUIRED (WORKING), with Good all-round knowledge, to Take Charge under head of Maintenance Staff of Factory in North London.—Address, 4162, The Engineer Office. 4162 A

HYDRAULIC ENGINEER.—An Old-established Firm of Engineers have a VACANCY in London for a capable ENGINEER with experience in preparing, supervising and servicing Pumping and Water Softener Installations. Permanent position with good prospects for suitable man. Apply by letter, giving copies of reference and details of education and experience.—Address, 4138, The Engineer Office. 4138 A

GENERAL WORKS MANAGER.—Large FIRM, producing tonnage product employing thousands of hands, invites APPLICATIONS for POSITION of GENERAL WORKS MANAGER PRODUCTION ENGINEER with managerial experience essential.—Write in first instance to SIR ALEXANDER GIBB AND PARTNERS, Queen Anne's Lodge, Westminster, S.W. 1, stating fully qualifications and experience. Commencing salary £4000 per annum. Excellent prospects for right man. 4063 A

EXPERIENCED SALESMAN REQUIRED by London Merchant Firm for Malaya. Essential qualifications :—Knowledge of Rough Goods, Organising Experience; age not over 28, single, good education, and appearance. Excellent prospects; first-class passages paid.—Write, with full details, 4171, The Engineer Office. 4171 A

LARGE ROADSTONE MANUFACTURING COMPANY REQUIRE experienced CHIEF ENGINEER; must be capable designer, and Take Charge of Drawing-office. Initiative, energy, and capacity to ensure operation of a number of plants essential. Only first-class men need apply, stating experience (fully), age, and salary required.—Address, P6565, The Engineer Office. P6565 A

MECHANICAL ENGINEER.—VACANCY Exists in moderate-sized Steel Works in Sheffield for a first-class practical MAN to Take Charge of Construction, Maintenance and Workshops. Good opening for energetic all-round man. Apply in first instance, stating fully and categorically (1) age, (2) training, (3) experience, (4) war service (if any), (5) salary required, (6) when available, (7) latest references.—Address, 4116, The Engineer Office. 4116 A

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., REQUIRE DRAUGHTSMEN with experience of Marine Motor Control.—Apply, with particulars of age, experience, and salary required, to the COMPANY'S EMPLOYMENT DEPARTMENT, Trafford Park, marking envelope "Marine Control Draughtsman." 4137 A

OPERATION PLANNING AND RATEFIXING DEPT.—Live, energetic and experienced MAN REQUIRED to Take Charge of above in General Engineering Works. Applications must state age, full particulars of experience, and salary required, and will be treated in confidence.—Address, 4174, The Engineer Office. 4174 A

SITUATIONS OPEN (continued)

REPRESENTATIVE REQUIRED, Preferably with connection in London, for large modern Engineering Firm in London, manufacturing all kinds of Steel Plate Work, Petroleum Refining Plants, Storage Tanks, Pressure Vessels, Chemical Plants, &c.—Write, stating age, experience, terms, &c., in strict confidence, to Box 646, Sells Advertising Offices, Fleet-street, E.C. 4. 4144 A

REPRESENTATIVE WANTED by Tool and Machinery Merchant, to call upon engineering works, dry docks, contractors, &c., in Bristol and West of England. Full particulars of age, experience, and salary required.—Address, P6545, The Engineer Office. P6545 A

YOUNG MAN for Experimental and Development Work on Small High-speed Diesel Engines. Engineering Degree and some practical experience required, with ability to think for himself.—Address, with details of experience, age, and salary expected, P6548, The Engineer Office. P6548 A

WORKS MAINTENANCE ENGINEER REQUIRED for Large Factory in Midlands.

A suitable man for these duties, involving supervision of maintenance staff, responsibility for running of plant, power-house, &c., upkeep of buildings and roads.

Must be experienced in Three-phase Power Distribution.

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A Seven-Day Journal

The Guggenheim Safe-Aircraft Competition.

FROM a fund of £500,000 left by the late Mr. Daniel Guggenheim for the promotion of aeronautics, there was set aside in 1927 a prize of £20,000 and five prizes of £2000 each to be offered in a safe-aircraft competition. Brief particulars of some of the requirements to be fulfilled by the competing aircraft were given in our issue of June 17th, 1927. They were such as to exclude all "freak" types of aeroplane, and although stringently drawn were not beyond attainment. Entries were receivable after September 1st, 1927, and it was intimated that the competition would be completed on or before October 31st, 1929. In our issue of October 14th, 1927, we were enabled to announce that several well-known aeronautical firms had submitted definite applications for permission to take part in the competition, including five British firms—the Cierva, de Havilland, Gloster, Handley Page, and Vickers companies. In all twenty-seven manufacturers entered for the competition, but only fifteen of them presented machines at Mitchell Field, Long Island, for testing. Of the British entrants, the Handley Page Company alone came forward with a machine. When the Handley Page machine made its appearance at Mitchell Field, many American observers are reported to have expressed the opinion that it would secure the prize. It did, in fact, succeed in passing the majority of the qualifying tests, but, according to the official statement of the Committee of the Fund, it failed to exhibit the minimum gliding speed of 38 miles an hour required by the rules of the competition, its best performance in this respect being 39·7 miles an hour. On the other hand, the machine submitted by the Curtiss Aeroplane and Motor Company, of the United States, was held to have passed all the qualifying tests, and as it was the only machine which was found capable of doing so, the prize of £20,000 was awarded to it. The judges included Mr. Orville Wright, Mr. F. T. Davidson (U.S. Assistant Secretary for War), and Admiral Byrd (the Arctic airman-explorer). Something more is likely to be heard of the result of the competition, for it appears that the Curtiss machine was fitted with the patented Handley Page slotted wing device, and that as a consequence it is alleged to have infringed an agreement made by Mr. Page with the American Government whereby the Government was given exclusive use of the device.

The Foundation Company.

THE Foundation Company, general engineers and contractors, of London, has announced this week that, owing to a heavy lock-up of capital abroad, it has been unable to provide the interest on the secured notes and the dividend on its preference shares due for payment on January 1st. In order to protect the position, Mr. J. H. Stephens, of Lescher, Stephens and Co., London, has been appointed by the Court of Chancery to act as receiver and manager of the undertaking. The company is under contract with various public authorities to carry out several important works, and it is hoped that arrangements may be made by which the continuity of the work will not be interfered with. The company has an authorised capital of £500,000, of which £425,000 has been issued. Last March a circular issued by the board stated that the contracts and work actually in the hands of the company at that time had a total value of more than £2,000,000.

The Late Professor A. A. Michelson.

BY the death of Professor Albert Abraham Michelson we have lost a physicist whose place in the history of science will always be secure by virtue of the fact that his failure to detect the motion of the earth through the ether provided the foundation on which Einstein built his whole theory of relativity. His celebrated experiment was made in the 'eighties of last century at Cleveland, Ohio, in collaboration with the late Professor E. W. Morley. It consisted in brief in sending two beams of light outwards at right angles, one parallel with the direction of motion of the earth, and reflecting them backwards to their origin. With the aid of an extremely delicate interferometer which he had devised, Michelson sought to detect and measure the effect of the earth's velocity on the velocity of the beam of light sent out parallel with the earth's course. No result was noticed, although from the known velocities of the earth and of light, the effect which Newtonian physics predicted should exist was well within the field of what could be measured by the means provided. He was seeking to detect the Döppler effect in connection with light instead of sound. He found none. Several ingenious efforts were made to explain the absence of result without straining Newton's system of natural philosophy, but none commanded any approach to general acceptance until Einstein formulated his theory of relativity, a theory which may be said to take as its corner stone the denial of the existence of the Döppler effect so far as light is concerned. Michelson was born at Strelno, in Germany, on December 19th, 1852, but at a very early age migrated with his parents to the United States. In 1873 he graduated at the Naval Academy, and later continued his scientific studies at Berlin, Heidelberg, and Paris. In 1883 he returned to America and was appointed Professor of Physics at the Case School of Applied Science at Cleveland. Subsequently, he was given a similar post, first at Clark University and then at the University of Chicago. In 1907 he received the Nobel Prize, and thereby became the first American scientist to be so honoured. In that year also he was awarded the Copley Medal of the Royal Society. He was a member of many of the world's leading scientific bodies, and was the recipient of honorary degrees from eight of the world's universities.

L.N.E.R. High-pressure Locomotive.

ON Tuesday last Mr. Gresley's high-pressure locomotive came to town, and on Wednesday morning, after she had been photographed by a score of professional cameras, had been "filmed" in various attitudes by half a dozen more, and had recorded a few characteristic noises—bar blowing off at 450 lb.!—for a "talkie," she made a trial run to Hitchin and back, with a dynamometer car and a couple of saloons behind the draw bar. With such a trifling load she could make no exhibition of her capacities, and with the earliest possible cut-off there was no call for high pressure, the needle never being taken up even to 300. But she showed herself to be astonishingly comfortable, and was obviously handled with ease. The footplate is very steady, possibly owing to the arrangement of the rear carrying wheels, described in our last issue, and the front end arrangements for carrying the steam and smoke away from the cab windows acted perfectly, the fumes being thrown up well over the boiler top. Crowds assembled at the stations through which she passed coming south on Tuesday, and at King's Cross on Wednesday, and naturally there were many comments upon her remarkable appearance. As a matter of fact, the only two pictures which do any justice to her are those we gave in our issue of last week. She gives an impression of great power and great dignity, and the beautiful skill with which the planished iron casing has been designed and worked removes entirely any sense of incongruity. One feels that she is right for her job, and all will hope that this most recent effort of British engineers will be crowned with success.

Suggested Road Bridge Across the Forth.

ON Tuesday a deputation representing Edinburgh, Dunfermline, Inverkeithing, South Queensferry, Fife County Council, and the Forth Conservancy Board, waited on the Minister of Transport to lay before him the case for the construction of a £6,000,000 road bridge across the Forth at Queensferry. Supporting the scheme, the Lord Provost of Edinburgh said that while the bridge would mainly be for the benefit of through traffic and should therefore be regarded as a national work, Edinburgh would be prepared to consider making a limited contribution towards the cost of constructing it. The deputees were apparently not quite united in whole-hearted support of the scheme. The Earl of Elgin, representing the Fife County Council and the Forth Conservancy Board, said that these two bodies were very doubtful as to whether the expenditure of £6,000,000 on a road bridge was justifiable. An efficient ferry service, he added, could be provided at Queensferry for about £500,000, and with a new road bridge near Kincardine, costing about the same amount, would meet all requirements. The Minister of Transport admitted the necessity for improved road facilities across the Forth, but, like the Earl of Elgin, he doubted the economic justification of the expenditure involved in carrying out the proposed scheme. He suggested that all the local authorities concerned should meet in joint conference to consider the best way in which to secure the desired end. He was impressed, he stated, with the advantages of providing an improved ferry service at Queensferry, together with a road bridge at Alloa. He preferred a bridge at Alloa to one at Kincardine, as mentioned by the Earl of Elgin. Plans already existed for the Alloa Bridge, and the work of construction could be put in hand at once. The Kincardine Bridge scheme had, however, so far only been worked out in broad outline

Three Railway Landslides.

THREE landslides on railways have taken place during the past week, all of which have been directly caused by subsidence following the recent heavy rains or by sea and gales. After a heavy south-westerly gale on Saturday night last, it was found that the sea had undermined the Great Western Railway track between Dawlish and Dawlish Warren, and that the rails with their sleepers were entirely unsupported for a length of about 50ft. The sea had completely undermined the track and had penetrated the full width of line to a protecting wall beyond. The train service was suspended, and with the low tides and the finer weather at the beginning of the week, thorough repairs to the sea wall and the bed of the track were carried out, and it is hoped that normal traffic will shortly be resumed. While standing outside the Wadhurst Tunnel on Monday evening, the rear coaches of the 5.5 p.m. up train from Hastings to Charing Cross were partly buried by a landslide from the high embankment above them. Single-line working was resorted to, and the same evening the line was cleared. Happily, no one was injured. At Munchalls Station, some 10 miles south of Aberdeen, on the London, Midland and Scottish Railway, a landslide which occurred on Monday carried away half of the east platform, and left the main line from Aberdeen to the South within 6ft. of the sandy edge of the Strathbarrel Gully, which runs inland for a considerable distance, with a steep fall to the sea. Precautionary measures have been taken, so that the traffic can be continued with safety.

The Ben Nevis Tunnel.

THE 15-mile tunnel through the Ben Nevis range in the Lochaber Power scheme was completed at 3.0 p.m. on Friday of last week, when the last face of rock was blown into Loch Treig by explosives and the water entered the mouth of the tunnel. About 100 yards from the edge of the loch the tunnel is divided into two sections, and to each section a shaft 145ft. deep, with a heavy sluice gate, was sunk. After passing the sluice gates the two tunnel sections again merge into one, and some distance along the tunnel a bulkhead, or plug of concrete, was built up. In order to create a bell-mouth at the entrance to the tunnel the last 16ft. of rock was bored; 135 holes, each tapering from 3in. to 1in. in diameter, being made from the workings up to as close to the water face as possible. In these shot-holes about 4000 lb. of special explosive were placed. In order to ensure that the final wall of rock would be blown out into the loch, a head of water some 40ft. above the level of the loch was maintained in each of the two shafts. When the firing switch was closed a dull muffled rumble was heard, and the gases caused by the explosion slowly rose to the surface of the loch and made a frothy circle about 30 yards diameter. The level of water in the shafts immediately fell to the level of the loch, indicating that an opening had been made. The sluice gates were at once closed, and after running off the water in the section of the tunnel between the sluice gates and the concrete plug, the bulkhead formed by the plug will be removed. When the bell-mouth opening has been inspected by divers to see that a clear passage has been made, the sluices will be again opened to allow water to pass through the tunnel and pipe line to the turbines at the Fort William factory. The tunnel has been constructed by Balfour, Beatty and Co., Ltd., contractors, and Messrs. Meik and Halcrow, of Westminster. engineers.

A New Fast Motor Ship for North Sea Service.

THE new motor ship for the Bergenske Shipping Company's Bergen-Newcastle service, which is being built by the Elsinore Shipbuilding and Engineering Company and engined by Burmeister and Wain, Ltd., in Denmark, is to have a speed of 19½ knots when supercharged, and will be able to make the voyage from Bergen to Newcastle, quayside to quayside, in 21 hours. She will incorporate the latest safety equipment and her length will be 412ft. 10½in., with a beam of 54ft. Her displacement on a 20ft. draught will be about 6950 tons, and her measurement about 5600 gross tons. Modern cargo holds and refrigerated cargo spaces with the latest cargo-handling devices, are to be fitted. The propelling machinery will comprise a twin-screw arrangement of ten-cylinder, four-stroke, single-acting oil engines of the airless injection type, which will be designed to operate with Burmeister and Wain's latest type of supercharger driven direct from the main engines. The normal engine speed will be 155 r.p.m., at which about 11,000 I.H.P. is to be developed with the engines unsupercharged, and 12,4000 I.H.P. with both superchargers in operation. When carrying 2000 tons of cargo, the maximum power given above will correspond to a speed of about 19½ knots. Besides the main engine-room a special auxiliary engine-room is to be provided, in which three 180 kW generator sets, driven by three-cylinder Burmeister and Wain engines of 250 B.H.P. output, are to be installed.

Electrification on the Southern Railway.

ON Sunday, January 5th, an electrified extension of the Southern Railway, linking Wimbledon and Sutton, was put into operation. The service is being worked between Holborn Viaduct and West Croydon in both directions, giving connections at Sutton with services to and from Victoria and at Wimbledon with services to and from Waterloo. During business hours trains will be run every 20 minutes and every half-hour at other times, and the trains will be made up of eight coaches with accommodation for 112 first-class and 540 third-class passengers. Building was begun on the line, which is 5½ miles long, in October, 1927, and the work has been done by the Southern Railway engineers and Sir Robert McAlpine and Sons, Ltd. The total cost of the work has been rather more than £1,000,000. The line is electrified throughout on the standard direct-current system and is served by the power-house at Wimbledon and the sub-station at Sutton. Wimbeldon Station has been adapted to allow trains to pass through to St. Paul's, Holborn Viaduct, and other main stations by way of Tooting Junction, while the junction at the Sutton end allow the trains to run in on the Epsom–Sutton line.

Electrical Engineering in 1929.

No. II. (*Conclusion*)*

Switchgear.

One of the most notable switchgear installations put into service during the year was that supplied by the Metropolitan-Vickers Electrical Company for the Portishead power station of the Bristol Corporation. The metal-clad units of this installation are the largest that have been constructed for draw-out operation, the breaking capacity of each unit being 1,000,000 kVA at a pressure of 33,000 volts. Various improvements in metal-clad gear were made by this company. The excellent performance of quick break contacts has led to the adoption of them for all pressures down to and including 22,000 volts. In the smaller sizes of metal-clad breakers, tests led to the development of improved arcing and main contacts which are said to possess remarkable features. New switch units for heavy current service at consumers' voltages and for use on industrial installations were developed. Many important switchgear orders were received by this firm, several of which were the result of the national electricity scheme. Existing switchgear was extended to allow for interconnection with the Central Electricity Board's system, or was remodelled so that the local system could be connected up without difficulties arising as the result of the large amount of power plant connected to the grid. Owing to the high capacity of the interconnecting transformers that are being used by the Central Electricity Board, problems have arisen in connection with the control of large currents at high voltages, and these problems have been successfully solved. Extensions to meet these requirements took place at Brighton, Greenock, and Islington, and reconstruction was undertaken at Aberdeen. Other Metropolitan-Vickers contracts include direct-current traction switchboards with high-speed breakers for the Windsor and Gravesend electrification scheme of the Southern Railway. Many kiosks were supplied to the Irish Free State Electricity Commission for various small towns and villages that are being fed from the Shannon power station.

One of the most important switchgear improvements was the development of pressed steel control panels with the necessary fittings for securing the control wiring and other panel details, a form of construction that provides flexibility in design, good protection of the wiring and equipment, and gives complete protection to the operators. Panels of this type are being supplied for the control boards for the North Western section of the "grid" contract. In the Western ring of the Central Scotland section of the "grid," the stations at Dalmarnock, Clydesmill, and Yoker were connected at 132,000 volts, these being three of the seven stations in this section for which high-voltage switchgear is being supplied by the Metropolitan-Vickers Electrical Company, which also has switchgear in hand for eleven sub-stations belonging to the North-Western section. Other important contracts are also in hand.

The most notable developments in B.T.H. switchgear during the year, related to the high-voltage apparatus for the sub-stations of the Central Electricity Board, particularly for the 66-kV section of the South-East "grid" and the 132-kV Mid-East "grid." For these contracts oil circuit breakers of fabricated construction were developed for interrupting capacities up to 1,500,000 kVA. The fabrication of oil circuit breaker containers was extended to the internal operating mechanisms, and the solenoid and centrifugal mechanisms which are now almost entirely built up of fabricated members.

Many B.T.H. oil circuit breakers of high interrupting capacity were designed during the past year, including 88-kV breakers at 1,000,000 kVA, 33-kV breakers at 1,500,000 kVA, and 22-kV breakers at 750,000 kVA. The first two of these breakers employ the well-known explosion chamber contact in conjunction with substantial containers capable of withstanding the high gas pressure developed when interrupting heavy short circuits. Notwithstanding the high mechanical strength attending the construction of these breakers, an additional safety factor has been introduced in the form of a pressure relief diaphragm, which is designed to fracture at a pressure roughly midway between the maximum calculated working pressure and that corresponding to the elastic limit of the material from which the containers are constructed. These diaphragms are now fitted by the British Thomson-Houston Company to all oil circuit breakers of 750,000 kVA interrupting capacity and above. The device relieves internal pressure caused by sustained arcing and eliminates the oil fire risk, the oil being discharged into a gravel catch pit designed to suppress combustion.

A considerable amount of metal-clad switchgear was built and an important order was secured for 33-kV duplicate breaker oil-filled switchgear of the drop-down pattern for the Ironbridge power station of the West Midlands Joint Electricity Authority. This switchgear is the first of its kind in Great Britain, and embodies many novel features, the most important of which are separate metal enclosures for each phase; physical separation of the duplicate bus-bars; two independent breakers per circuit, one breaker being associated with each bus; and, finally, oil filling with conservators for all-metal enclosures.

With regard to the smaller sizes of metal-clad switchgear, welded components have been introduced where cast iron was formerly used, and oil-immersed selector devices have been developed, which permit bus-bar change-over without shutting down the circuit to transfer the bus-bar plugs. Many orders for home and abroad were received and executed by the B.T.H. Company during 1929 for metal-clad switchgear for pressures of from 6600 up to 33,000 volts, and for interrupting capacities ranging from 100,000 to 750,000 kVA.

During the year extensions to the switchgear shops of the English Electric Company were put into service, and the switchgear output was considerably increased. A good demand was experienced for metal-clad switchgear. From the Central Electricity Board the company received an order for switchgear of this type for the North-West England scheme, and another order was obtained from the Croydon Corporation and the Central Electricity Board jointly, the approximate value of the two contracts being £140,000. There are thirty-six units for the North-West England scheme designed for a 33,000-volt system with rupturing capacities of 500,000 and 750,000 kVA, whilst the fourteen units associated with the Croydon Corporation and Central Electricity Board contract are designed for 6600 volts and have a rupturing capacity of 1,000,000 kVA. A large 33-kV outdoor sub-station, designed for linking up with the "grid," is being erected by the English Electric Company at Little Barford on the Bedfordshire, Cambridgeshire, and Huntingdonshire system. The demand for kiosks, truck cubicles, and industrial pillars was exceptionally good.

A feature of interest in connection with the "grid" switchgear is that when the first tender was put in for the Scottish "grid" the General Electric Company

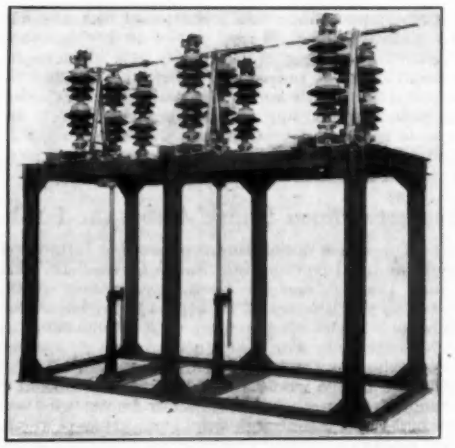


FIG. 3—66-kV ROTARY ISOLATING LINK—G.E.C.

submitted a rotary type isolating link, which was adopted by the Central Electricity Board, and has since been used as the standard link for all the schemes. The illustration—Fig. 3—shows a 66-kV, 300-ampère, rotary isolating link, mechanically interlocked and fitted with line earthing switches, which are shown closed in the illustration. They are operated at the ground level by rotating an adjustable lever in a horizontal plane. This lever when not in use, is dropped into a vertical position and is padlocked to prevent unauthorised interference. The company's "grid" outdoor oil circuit breakers have a breaking capacity of 1,500,000 kVA, at a pressure of 132 kV. After an exhaustive study of the various methods of suppressing the arc, four breaks per phase were adopted to the exclusion of explosion pots. G.E.C. metal-clad switchgear is now available for breaking capacities up to 1,500,000 kVA at 66,000 volts and currents of 400 ampères. Several orders for large capacity boards of this kind were received last year, and one for the London Power Company is for 1,000,000 kVA gear working at 22,000 volts, for use in connection with the "grid" scheme. The Corporations of Leeds, Sheffield, Eastbourne, Birmingham, and Battersea were among the company's clients for metal-clad gear. The demand for other types of G.E.C. switchgear was also good. The G.E.C.-McColl protective gear was modified to make it suitable for the 132-kV overhead lines. While it was unnecessary to depart very widely from the methods standardised for general working, much more stringent tests than usual have had to be carried out to ensure stability of the system. The protection of parallel interconnectors was rendered more reliable and sensitive by the introduction of a new G.E.C. biassed directional relay, which has been applied to a number of lines. In one case step-up and step-down transformers have been included in each of the feeders, with satisfactory results. Protective gear with a sensitiveness of 4 per cent. was applied to the large 37,500-kVA turbo-alternators at Hams Hall. G.E.C. automatic control gear received an impetus by the introduction of two lines of small mass-produced starters for motors up to 3 and 5 horse-power respectively. Very important developments were made in connection with the automatic control of apparatus on ships. A new line contact circuit breaker was developed by the company, and in it full advantage is taken of the self-aligning property of "V"-edged blades bedding in grooves. An increasing demand is being experienced by this company for high-speed breakers, which are now available at prices considerably lower than those that prevailed a few years ago. Whilst originally used on railway electrification schemes, these breakers are now employed on tramways and light railways. A new feature, we are told, is the application of large capacity circuit breakers in place of fuses, and that has been done on a large scale in Marylebone, where several hundred circuit breakers of 1000 or 2000-ampère capacity have been supplied.

Hydro-electric Plant.

Early in the year an order was received by the English Electric Company from the Public Works Department of the New Zealand Government for two 16,666-kVA alternators for the Waitaki power station. The machines are vertical-shaft alternators, similar to three units in hand for the Perak river scheme, and will run at a speed of 125 revolutions per minute. For the Grampian scheme, the company is supplying two vertical reaction type turbines, designed for a speed of 500 revolutions per minute, an average output of 17,000 horse-power at 532ft. head, and a maximum output of 22,000 horse-power. The station will be situated on the shore of Loch Rannoch, and will utilise the water of Loch Ericht, with a maximum static head of 541ft. For Nigeria and Tasmania the company also received two important orders. The former is for a 6000 horse-power set for the Nigerian Electricity Corporation, and is to be installed in the Kurra Falls station. The turbine is a horizontal high-pressure reaction machine, and operates under a static head of 750ft. at a speed of 1000 revolutions per minute. The Tasmania contract consists of two 7250 horse-power horizontal-shaft reaction machines, each driving a 5300-kVA, 6600-volt, 50-cycle alternator at 500 revolutions per minute under a net head of 244ft. The sets will be installed in the Shannon River station, which is being built to utilise the head at present lost between the Great Lake and the Shannon diversion, from which the 63,000 horse-power Waddamana station is fed. While both ends of the sets will be manufactured at the English Electric Company's works, some of the parts of the turbine and the two cylindrical balanced valves will be manufactured in Australia. An order has also been placed with the company for two vertical shaft alternators for the Arnold River station of the Crey Electricity Power Board, New Zealand. Each machine will have an output of 1800 kVA at 3300 volts, 50 cycles, and will run at 300 revolutions per minute. The erection of the five 9000 horse-power impulse water turbines, with their two 3000-kW tandem direct-current generators in the Lochaber power-house of the North British Aluminium Company, is well advanced, and will be completed early this year. When finished, this will constitute the most important hydro-electric installation in Great Britain. Good progress was also made with the reconstruction of the same company's 3200 horse-power water tubines at Kinlochleven, five of the reconstructed units now being in commercial service. Official tests taken on the first units showed that the efficiency had been increased by no less than 16½ per cent., equivalent to an increased output of 22 per cent. The latest news from New Zealand states that the 12,650 horse-power horizontal reaction turbine, with its 7500-kilowatt alternator, has been started up at the Lake Coleridge power station of the Public Works Department. This is another of the combined units supplied by the English Electric Company, and the erection has been carried out by the company's agents, Cory-Wright and Salmon. Another important hydro-electric undertaking that will be put into operation during the present year is that on the Perak River, for which the English Electric Company is supplying three 12,350-kVA, 6600-volt, 50-cycle alternators of the vertical type, and designed for a speed of 93·75 revolutions per minute. Altogether, 1929 may be regarded as a year of steady progress for the hydro-electric department of the English Electric Company.

Among the alternators supplied by the Metropolitan-Vickers Electrical Company for water-wheel sets were four machines for India.

At the Rugby works of the B.T.H. Company two 20,000-kVA vertical water-wheel alternators were constructed for the Grampian hydro-electric scheme, which is being carried out by Balfour, Beatty and Co., Ltd. The B.T.H. Company is also building the necessary transformers for stepping up to the line transmission voltage at Rannoch, and corresponding transformers at Abernethy, where the power will be delivered to the Scottish "grid." For the Nigerian Electric Supply Corporation, Ltd., three B.T.H. 1770-kVA water turbine sets were shipped, each comprising a Pelton wheel by James Gordon and Co. and a B.T.H. alternator; also a 100-kW auxiliary oil engine set, together with the power station switchgear, &c. The B.T.H. Company is also dealing with an order for a 6600/33,000-volt outdoor step-up sub-station, with six 1700-kVA single-phase transformers, switchgear and lightning arresters; a 33,000-

* No. I. appeared January 3rd.

volt switching station; a main step-down outdoor sub-station for 33,000/3300 volts; and six 500-kVA three-phase transformers with switchgear for step-down outdoor sub-stations. Extensions to the Waipori hydro-electric scheme of the Dunedin City Council, New Zealand, have resulted during the year in an order being received by the British Thomson-Houston Company for a further 3750-kVA, 2400-volt alternator, this machine being similar in all respects to one of those already in service. It may be remembered that the generating units for this scheme are either automatically or manually controlled. For the works in connection with Pykara hydro-electric scheme, India, two B.T.H. 375-kVA, 750 r.p.m., 400-volt, three-phase, 50-cycle alternators, driven by Boving turbines, were shipped, and another is on order. The electric power generated will be stepped up to 11,000 volts for distribution to the Pykara scheme works.

Electric Traction.

The inauguration of the G.I.P. main line electrification scheme from Bombay to Poona was an important event of the year, constituting as it does the largest main line electrification scheme in the Empire. The complete scheme was described in our issue of November 15th, and it will be remembered that a number of goods and passenger locomotives were supplied by the Metropolitan-Vickers Electrical Company, which is also building twenty-one additional locomotives which will be completed and shipped within the next six months. Two notable multiple-unit train equipment orders were secured by this company during the year—one for the Southern Railway covering equipments for thirty-two motor coaches and twenty-two trailer coaches, and the other for the Central Argentine Railway, covering equipments for forty motor coaches and thirty-six trailer coaches. In one of the new tramcar drives developed during the year by this firm, worm gearing is employed instead of the usual spur gearing. The motor gear and gear case is entirely spring-borne, and is carried from the main frame of the car. The worm gearing is mounted in an extension of the motor frame, and drives a hollow quill surrounding the axle. On account of the spring suspension, there is, of course, a certain amount of movement between the axle and the quill surrounding it, and the drive is taken through a universal coupling which permits the necessary relative displacement of these two parts in all possible directions, except in pure rotation. Another equipment is arranged on similar lines. The usual spur gearing is, however, retained, but noise is largely eliminated by the use of the single helical type of spur gearing. The motor and gearing, together with a quill, constitute a spring-borne unit, and the drive is transmitted to the axle through a universal coupling. Ordinary motors supported by springs were also built, and instead of the gear centre distance being maintained by the use of ordinary axle bearings, guide bearings only are used. The development of the application of ball and roller bearings continued, and for tramway motors, it is now this company's general practice to employ a standard roller bearing at the pinion end and a double lipped roller bearing for location at the commutator end. Roller type armature bearings were successfully applied in the case of a large contract for axle-hung motors of 270 horse-power for the Metropolitan Railway. The Metro-Vick contactor type tramway controller was modified to make it suitable for four-motor equipments, a development that was rendered necessary to meet the requirements of the London County Council tramways in connection with trials of four-motor tramcars for hilly routes. The overall dimensions of the four-motor controller are no greater than those of the standard two-motor controller, and the extra gear has been accommodated without sacrificing accessibility.

New designs and improvements in unbreakable resistances were introduced by the B.T.H. Company, and they are said to be giving excellent results in service. New types of controllers were developed to meet the arduous demands on control equipment on account of the more general use of more powerful motors on both two-motor and four-motor equipments. By means of an attachment, existing controllers may be converted for shunted field operation with or without automatic relay control. New designs of the B.T.H. contactor control for trolley omnibuses are being developed with the object of providing for the transfer of the energy required for retardation to unbreakable resistances, so as to reduce the excessive wear of the brake drums. This scheme of electric braking is designed for graduated application, either automatic or otherwise. Further contracts were secured by the B.T.H. Company for the supply of control equipments for motor coaches on the Underground Electric Railways of London. Mention should also be made of an order from the South American and General Committee for thirty tramway motors and control equipments for the Montevideo tramways. An order is also in hand for sixty similar motors for the Anglo-Argentine Tramways, Ltd., Buenos Aires.

The English Electric Company's most important electric tramway contracts were placed by the London County Council Tramways. Orders were received for 100 tramcar equipments, including light-weight motors and hand-operated camshaft controllers of the latest type and fifty tramcar bodies of all-metal construction. Many other new and repeat orders for cars and equipment were received from various tramways at home and abroad. We are told that English Electric omnibus bodies are finding increasing favour. The Bradford, Darlington, Maidstone, and Nottingham Corporations placed orders for trolley omnibuses. An important railway contract recently received by the company is for the South Indian Railway, and includes seventeen train units, each consisting of one motor coach and two trailing coaches. Each motor coach is to be equipped with four 120 horse-power motors and multiple-unit control of the cam shaft type. The order also covers four 40-ton goods electric locomotives, each equipped with four 165 horse-power motors and similar type of control gear to that mentioned. In Japan twenty-three motor coach equipments of the English Electric multiple-unit cam shaft type were put into service.

An important order received by the General Electric Company was for 1500-volt railway equipment for the Manchester–Altrincham line, which is owned jointly by the L.M.S. and L.N.E. railways. The order covers 100 heavy railway motors, each rated at 328 horse-power on the one-hour rating, together with electro-pneumatic type control equipments for twenty-four motor coaches, twenty-two trailer coaches, and twenty-two driving trailer coaches. Incidentally, this is the first order placed in this country by home railways for equipment for trains operating on a 1500-volt system. The order for the whole of the electrical equipment for two sub-stations feeding the overhead line has been placed with the B.T.H. Company. For a new tube railway, the Buenos Aires Central Terminal, the General Electric Company is supplying fifty-six sets of electrical equipment for motor coaches, each including two 105 horse-power motors with the necessary undercar electro-pneumatic contactor type control gear, together with lighting equipment, &c. Many orders were also received by this firm for standard tramway motors and control equipment, one covering over 100 motors for Auckland, New Zealand.

Research.

Good progress was made during the year in the direction of stabilising the finances of the British Electrical and Allied Industries' Association. A conference of representatives of interested sections of the industry issued an appeal for support. The railway groups agreed upon their quota and satisfactory replies are coming to hand from authorised undertakings and manufacturers. Further reports were prepared for the Electricity Commission and additional work was undertaken at its request. The reports already issued give authoritative pronouncements on problems of considerable importance in the development of electrical distribution in this country at the present time. The work on interference with communication wires undertaken for the Central Electricity Board, in co-operation with the G.P.O. and engineers interested, was brought to a satisfactory issue. The problem of the effects of earth returns under normal and abnormal conditions of working received special attention in relation to the "grid" system.

Having regard to the commercial importance of securing international agreement on figures representing the properties of steam for use in contracts for steam turbines and in design, and to certain differences existing between experimental results obtained by investigators in different countries, the Association invited the leading investigators and others in Europe and America to meet and discuss their methods and differences informally. Under the chairmanship of Sir R. Glazebrook, a successful conference was held in July and the preparation of skeleton steam tables was agreed to. They were issued in December and embody all the most reliable data available at the moment.

During the year foreign publications indicated that competitors abroad are alive to the necessity for a fundamental attack on the phenomena of circuit breaking. Novel devices are being developed for circuit-rupturing without the use of oil, thus eliminating a substantial fire risk. The Electrical Research Association was the first to adopt a comprehensive scheme of scientific research on this problem, as distinguished from empirical investigations of known devices, and has been able to secure patents which, it is believed, will be of fundamental importance in future developments. This important work, however, is still very much hampered by a lack of facilities for confirming the results at higher voltages and with larger amounts of power. Several important researches on the behaviour and rating of ordinary and heavy-duty fusible cut-outs were completed, and they are expected to be of considerable utility to the manufacturer, the B.E.S.A., and the I.E.E. Work was completed on methods of measurement of dielectric losses, the heating of cables in racks, and the transfer of heat from cables to duct walls, whilst important work on the heating of deeply buried cables, and the behaviour of cables under considerable changes of temperature was begun. The research on the transfer of heat from tubes to water in steam condensers was completed during the year, and reduced to a form for commercial use. Experimental apparatus for dealing with the problem of heat transfer from steam to tube is now being developed.

Up to the present, the Association has not secured the full co-operation of the wireless industry, and it has therefore had to limit expenditure on work in that field; but it has been fortunate in having secured the co-operation of pioneer workers on problems of measurement at the City and Guilds (Engineering) College and at the East London College. The application of four-point loading to beams, thus putting a large mass of material under substantially uniform conditions of stress, has opened the way to an analytical examination of the phenomena of plastic yield and of impact testing, and a start has been made on both problems as met with in composite insulating materials. Further proposals were prepared as a basis for British standard specifications for insulating materials, and good progress was made in co-operation with the B.E.S.A., in compiling and revising previous specifications. Good progress was also made with the problem of fire risks in relation to the I.E.E. Wiring Rules and the selection of materials for constructional purposes.

In the Wembley Research Laboratories of the General Electric Company a new type of photo-electric cell was developed. It is claimed to give ten times as much current for the same white illumination as the most sensitive cells previously made. It also has great sensitivity in the infra red. For use with photo-electric cells a new type of single valve amplifier which operates directly off A.C. or D.C. mains and has an output of 10 milliampères was developed. The amplifier has been applied with marked success to the automatic lighting of street lamps. Photo-electric methods of photometry were worked out under continuous service conditions, and both accuracy and speed of operation have been increased. An apparatus utilising photo-electric cells was developed for the measurement of colour temperature and luminous output, and as the temperature and lumen scales are linear, calibration of the apparatus is greatly facilitated. An asymmetric reflector was designed for use with low-wattage lamps, which enables directional lighting to be combined with a sharp cut-off which diminishes glare. Improvements in lamps have allowed of non-ventilated lanterns to be used in sizes up to 500 watts, thus eliminating the deposition of dirt on the lamp and reflector.

For testing overhead transmission line towers up to 100ft. high, a special plant was erected. Eight pulls, each of 15 tons, can be applied in one direction, with another eight of 10 tons each at right angles to the first series, the forces being measured by remote control instruments housed in a control room. During the year the towers for the South-East England and Mid-East England schemes of the "grid" 132-kV lines were tested by means of this plant, and towers for other schemes are now undergoing test. Tests have also been made on different types of foundations for these towers. There is also a conductor test plant upon which vibration and other mechanical tests are being carried out on the conductors and fittings used for overhead lines. A length of 250ft. of conductor can be accommodated and tensions up to 11 tons may be applied.

A considerable amount of work was done on the technique of acoustic measurement, and is being applied to electro-acoustic problems of various kinds. New methods were worked out for the quantitive measurement of the working properties of glass at high temperatures. The chief development in connection with wireless receiving valves was in the direction of designing valves for operation on A.C. mains. The characteristics of the indirectly heated cathode types were improved, and their cathode-heater power consumption reduced. The number of indirectly heated cathode valves was increased so as to meet the demands of all the positions in a receiving set, including the screened grid high-frequency stage.

A good deal of work was carried out in the research department of the Metropolitan-Vickers Electrical Company. An important research continued from previous years was on the noise emitted by electrical and mechanical machines. Measuring apparatus was developed for quantitatively measuring and analysing the noise, and the results are now influencing commercial practice. A paper on the subject was recently read before the Institution of Electrical Engineers. Several special equipments for works testing were devised and constructed in the department and put into operation in the works. Perhaps the most noteworthy was apparatus for rapid and accurate measurement of ratio errors and phase voltage in transformers up to 22 kV. A Schering bridge was also developed for insulation tests on finished bushings, capable of measuring dielectric losses of a few watts at voltages up to 300 kV. A grease of substantially zero vapour pressure was produced for making the joints, and an oil of similar properties, which overcomes the problem of mercury vapour and renders a liquid air trap unnecessary, has been used in place of mercury in the Langmuir pump. The capacity of the present pump is 20 litres per second, and the vacuum obtained 10^{-7} mm. of mercury. Considerable advance was made in the practical use of power valves. At the present time an oscillator valve of 20 kW input at 12,000 volts, which generates power at 600 m., is in use. It was felt that glass was too fragile to be satisfactory in

large size valves. Experiments with unglazed and glazed porcelain have, however, proved satisfactory, and as these valves can be made up to ¼ ton in weight, a new field is being opened up.

Two important additions to the laboratory were made. The first was a 1000-kV testing set obtained by connecting two 500-kV transformers in cascade, thus giving a power output of 1000 kVA. This set is now in use for investigational testing, and it has been found that a breakdown between a metal sphere, 50 cm. in diameter, suspended 12ft. above a metal plate, occurs at 970 kV. The second addition is an impact testing set in the form of a 50-cycle transformer, rectifier and capacity banks, arranged for the production of voltages up to 1400 kV, the time taken to reach the maximum voltage being 0·25 to 0·30 micro-seconds. The research engineers carried out a thorough investigation into the effects of various types of deposits on the behaviour of porcelain insulators, and much of this work has been described in a paper delivered before the Institution of Electrical Engineers.

Wireless Communication.

The Imperial beam wireless transmission continues to be one of the most remarkable achievements in wireless, and the development of multiplex telegraphy and telephony on the England-Canada beam has proceeded. Both the thanksgiving service for the King's recovery and the Cenotaph service on Armistice Day were transmitted over the England-Canada beam and rebroadcast in Canada with excellent results. The experiments made at Terling in co-operation with the B.B.C. on special aerial reception with a view to minimising fading in general broadcast reception for the purpose of rebroadcasting, made good progress, and on the occasion of his reception in New York, Mr. Ramsay MacDonald's speech was received on spaced aerials at Terling, and re-broadcast from B.B.C. stations. The B.B.C. system of broadcasting from a number of stations simultaneously on the same wave length has been rendered practicable by the method of tuning-fork control developed by the Marconi Company. Rapid advance was also made in the development of quartz crystal control as a means of stabilising the frequencies of wireless stations.

During the latter part of September the International Technical Consultative Committee for Radio-electric Communications at The Hague dealt with the question of frequency variation, and it was recommended that the tolerance, which should be applied immediately as far as broadcasting stations were concerned, should be ±300 cycles, and that in future it hould be reduced to ±50 cycles. It was also recommended that every fixed land station and all stations conducting special services, such as broadcasting stations, should be equipped with a frequency meter having sufficient precision to permit of the station's waves being adjusted within the tolerances mentioned. The Marconi Company has now concluded experiments on the measurement of high-frequencies, and has developed a precision wave meter to meet the recommendations of the International Technical Consultative Committee.

The year was remarkable for an all-round improvement in general performance of all classes of wireless equipment. The Marconi Company developed an entirely new range of wireless transmitters for naval and mercantile and marine and fishing fleet service. Direction finders and radio beacons were fitted in considerable numbers, and are now regarded as part of the standard equipment for safeguarding navigation. Aircraft apparatus also underwent vast improvements, and on the occasion of the International Aero Exhibition at Olympia a new range of receivers and transmitters for long and short-wave working was exhibited for the first time by the Marconi Wireless Company.

With the opening of the first regional broadcast station—see Figs. 4 and 5—broadcasting in Great Britain entered upon a new era and listeners in the wide area covered by the Brookman's Park station have now a greatly improved broadcasting service. British industry received a large share of the orders placed by European broadcasting authorities for the supply of high-power stations, and amongst the latest broadcasting stations installed by the Marconi Company are the high-power stations at Bratislava, Belgrade, and Bucarest. Important orders were also received by the same company for the installation of powerful broadcast transmitters at Brno in Czecho-Slovakia, Stockholm, Iceland, Warsaw, and a number of smaller stations for various districts in Poland and elsewhere.

FIG. 5—BROOKMAN'S PARK—SMALL MOTOR GENERATORS

Stockbroking on board ship has made the latest demands on the wireless service at sea, and the Marconi Company has overcome the difficulty of working an independent duplex wireless service within a few yards of the ship's main transmitting installation by the use of a special screened aerial for each set. The ordinary telegraph service between ship and shore can be carried on as usual without in any way interfering with the special brokerage service working in a nearby cabin, the design and arrangement of the aerial system being such that the two wireless cabins are completely screened from each other.

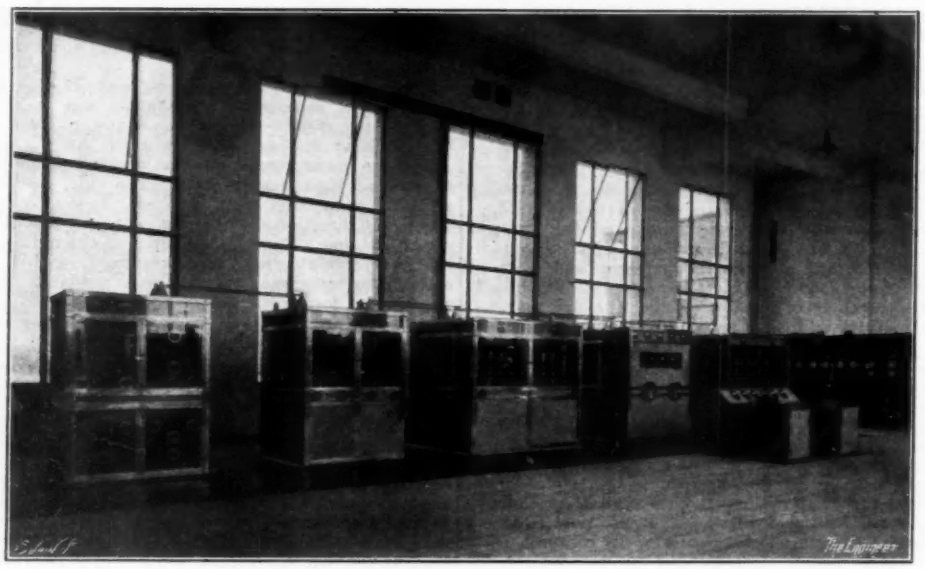


FIG. 4—BROOKMAN'S PARK—A TRANSMITTER AND PART OF MAIN SWITCHBOARD

The wireless and cable merger was a development of considerable importance. It will be remembered that the report of the Imperial Wireless and Cable Conference recommended the formation of a merger company to be known as Cables and Wireless, Ltd., to acquire the capital of Marconi's Wireless Telegraph Company, Ltd., and the Eastern Telegraph Company, Ltd. The report also recommended the formation of a separate company to be known as Imperial and International Communications, Ltd., to acquire the communication assets of the Marconi and Eastern Telegraph Companies, the Pacific Cable Board, the Empire Beam Services, Imperial Cables, and the West Indian Cable and Wireless System. During the year this merger became an accomplished fact, and the whole of the telegraph services were brought under the direct control of the Communications Company on September 30th, with the result that Great Britain now possesses the finest communication service in the world.

Turning now to the work of the Post Office, the station at Leafield, Oxfordshire, was redesigned as the main telegraph transmitting centre for continental wireless traffic. The 250-kilowatt arc transmitter completed in 1922 and the experimental short-wave transmitter which had been working since 1925 were dismantled, and replaced by three-valve transmitters working on medium wave lengths and two-valve transmitters working on short wave lengths. The power for the medium-wave transmitters is generated in the station, and the plant originally installed for the arc transmitters is used. Frequencies are controlled by tuning forks. The two final stages of amplification are provided by two air-cooled 1-kilowatt valves and six water-cooled 10-kilowatt valves in parallel, respectively. In each case the power output to the aerial is in the neighbourhood of 50 kilowatts. The coupling to the aerial circuit is variable. Slight differences in the aerial tuning are compensated for by a variometer in series with the aerial coil. The three antennæ are of the flat-topped "L" type, and the one furthest away from the station building is connected by a transmitting line ¾ of a mile long. At the distant end the aerial is coupled to this line, so that the line is properly terminated and reflection is avoided. The short-wave transmitters are worked with power taken from the Wessex Electricity Company, and are crystal-controlled, the fundamental frequency of the crystals being doubled in each of the three successive frequency doubling stages. There are two intermediate stages of amplification of 500 watts and 3000 watts respectively, and the output of the aerials is supplied by two 10-kilowatt water-cooled valves. Both transmitters are designed for keying either by the suppressed carrier method or by modulation of the carrier.

There are now four two-way telephone channels in regular operation between London and New York. The original experimental short-wave transmitter at Rugby has been replaced by a new one, and two others have been installed, the experimental transmitter now being used for tests to Australia and South Africa. The installation of two other transmitters is now in an advanced stage. The design of the telephone transmitter is similar to that of the telegraph transmitters, but provision is made for an additional stage of amplification by means of four 15-kW water-cooled valves. The transmitters are modulated at low power, although in the case of one of the transmitters, the alternative of high-power modulation of the second last stage is provided for.

Short-wave reception is carried out at the Baldock wireless station, where four high-grade receivers of the superheterodyne type are worked in conjunction with array systems of various kinds. A system of automatic gain control is provided in each receiver. Each channel is terminated in the necessary monitoring and control apparatus at the trunk exchange, London, where thermionic valve voice-operated devices, developed by the Post Office for the supression of "singing" and echoes, are installed.

The plants at the Niton, North Foreland, and Cullercoats stations were modernised. New 1½-kilowatt sets working on interrupted continuous waves were provided to meet the requirements of the Washington Convention. The dual-wave method of working, *i.e.*,

600 m. for calling and another wave for traffic, has been adopted at these stations, and a different I.C.W. note frequency has been adopted to assist ship's reception in the presence of jamming. The installation at each station also includes an emergency I.C.W. transmitter.

Miscellaneous.

Electricity now plays an important part in so many industries that any attempt to review twelve months' progress in a few columns of THE ENGINEER must fall a long way short of actualities. The mass of information that reaches us each year from electrical manufacturers covers a very wide field, and deals with all sorts of electrical industrial applications, such as the application of electricity to mining, the textile, iron and steel, and other industries. To deal with all this work is out of the question, but by way of conclusion we may refer in a general way to a few more items to which the manufacturers appear to attach importance. One of the most notable developments that are taking place in the manufacture of electrical equipment is the use of built-up welded structures for parts for which iron and steel castings were previously employed. The advantages of this form of construction have been set forth in our columns during the past year, and large electrical firms, such as the B.T.H. Company, the Metropolitan-Vickers Electrical Company, and C. A. Parsons and Co., Ltd., have given considerable attention to the manufacture of fabricated machines. The standardisation of frequency gave rise during the year to a good deal of work, including the construction of rotary converters for operation at 50 cycles per second. Incidentally, the size of rotary converters has increased within recent times, and the Metropolitan-Vickers Electrical Company is building some 4500-kilowatt machines capable of carrying overload peaks of 10,000 kilowatts for the Sydney suburban system. The B.T.H. Company is also supplying three additional 4500-kilowatt, 1500-volt, 25-cycle machines for the New South Wales Government Railways. As in previous years, there was an appreciable increase in the use of automatic and supervisory control gear in sub-stations.

Frequency changers, which at one time were very seldom met with in this country, are now being called for, one of the most notable salient-pole machines that were put into service during the year being a reversible 33,000-kilowatt set, with automatic regulating gear, installed by the Metropolitan-Vickers Electrical Company at the Deptford West power station of the London Power Company. The machine forms a link between the 25-cycle, 11,000-volt, and 50-cycle, 22,000-volt systems, and consists of two units each rated at 33,330 kVA capacity, but the set is provided with a special excitation system, which enables it to carry peak loads up to 100,000 kilowatts without falling out of step. Two 3000-kVA frequency changers were also supplied by the B.T.H. Company for use in connection with the Dublin tramways. There was considerable progress during the year in the design of protective gear, and two firms that gave particular attention to this matter were the General Electric Company and the Metropolitan-Vickers Electrical Company. One of the most interesting problems of the year was that of providing motors suitable for 25 and 40-cycle circuit systems, but capable of being rearranged with a minimum amount of trouble and expense to operate on a 50-cycle system when the frequency of the system is altered. To meet this need, motors have been designed by the Metropolitan-Vickers Electrical Company capable of simple and expeditious reconstruction for 50-cycle operation, and having the distinctive and important features that there are no idle windings and that the performance at either frequency is equal to that of a single-frequency machine.

An increase in the demand for motors equipped with power factor correcting devices was experienced. These machines, states the English Electric Company, Ltd., are of the salient-pole synchronous type or of the synchronous-asynchronous type, or induction motors fitted with rotating compensators. An outstanding example of the latter was a 2600 horse-power machine capable of starting up against a heavy torque and equipped with a compensator which enables it to work at practically unity power factor at all loads. A considerable demand was experienced by the same firm for variable speed A.C. commutator motors. In view of the fact that a totally enclosed motor is large for its output as compared with a ventilated machine, the English Electric designers have produced a machine which is a compromise between the two types. Whilst giving complete enclosure to all the vital parts, this so-called "Closvent" motor is smaller and cheaper than a totally enclosed motor of the same output. The motor is claimed to be suitable for use in all places where a totally enclosed machine is usually employed, such as wood-working factories, cement works, gas-works, &c.

COMMUNICATION by wireless, between the control tower and the engine pushing wagons up the hump at Whitemoor new marshalling yard, is being tried. It is from the control tower that the Frolich hydraulic wagon retarders are worked.

Water Supply in 1929.

No. II. (*Conclusion*).*

WE continue below our account of the progress made in water supply engineering during the past year.

Birmingham.

Bartley Reservoir.—The construction of the Bartley Reservoir was continued throughout the year, but the period for completion has been extended owing to slips on both the upstream and the downstream slopes. The original slopes have had to be considerably modified and a substantial amount of stone weighting has been added to the outer portions of the embankment on both the upstream and the downstream slopes. The latter now appear to have reached a stable condition and the work ahead consists in forming the upstream embankment to the flatter slopes by the addition of rubble.

Elan Aqueduct Third Main.—A substantial addition to the third line of pipes on the Elan Aqueduct was sanctioned by the Water Committee during the past year. Continuous progress was made by the three administrative gangs on the Downton, Teme and Severn syphons. The length of the third main now in commission amounts to 11½ miles. A further length of 59 miles is under construction and should be available for supply at the end of the present year.

Bradford.

The construction of the Scar House Dam was begun in 1921 and, as reported in our last Annual Article, a level of 104ft. 6in. above the bed of the river Nidd had been reached by the end of 1928. During the past year the general level of the completed work, which is of cyclopean masonry, was raised to within 20ft. of the top water level and various portions were actually carried up to that level, 154ft. 6in. above river bed level. The total volume of concrete and masonry in the dam will be 540,000 cubic yards, and of that amount nearly 510,000 cubic yards had been placed by the end of the year. During the past session of Parliament certain auxiliary works were authorised, viz., the construction of a catchwater over 4 miles in length to abstract water from the drainage areas of the Howstean Beck, its tributaries and certain smaller streams and a tunnel 1860 yards in length through which the waters collected by the catchwater will be conveyed into the Scar House Reservoir. Tunnelling was begun in May last and the heading was advanced for about one-third of a mile, passing chiefly through shale and sandstone. A lining of concrete is being placed therein, the finished dimensions being: width, 7ft.; height, 7ft. 6in. The construction of the catchwater will not be begun until after the completion of the tunnel, for through it the necessary materials for such construction will have to be conveyed. No water has yet been impounded in the reservoir, but it is anticipated that a beginning will be made with its retention during the next few months.

Chelmsford.

By a parliamentary Bill passed during the 1923 session, the Corporation of Chelmsford acquired the Sandford Mill property, which is situated 2½ miles below the town, together with the millers' rights regarding water flow &c. An intake was made on the mill stream, and the river water passes over a weir, 66ft. long, into an open channel leading to a reinforced concrete storage reservoir, which contains 3,060,000 gallons of water. From this reservoir the water passes over a long weir into the channel leading to treatment tanks of 1,000,000 gallons capacity. Sulphate of alumina solution and lime water are added to the water stream at the point of entry. The water flows alternately over and under the intermediate walls, and is allowed twenty-four hours' contact. It is finally treated with carbon dioxide gas to remove any excess of lime, and is pumped through pressure filters—of which there is a battery of eight—to a service servoir at Longstomps, 2½ miles distance.

The new Pumping Station has been built on the site of Old Sandford Mill. To utilise the power of the river water, when available, turbines with direct-coupled, 12in. by 12in. horizontal double-acting piston pumps, have been installed, a large 42in. diameter turbine developing 50 H.P. and a smaller one developing 26 H.P. When water power is not available the pumping is effected by crude oil engines, of 106 H.P. direct coupled to 12in. by 15in. vertical treble ram pumps, capable of pumping 42,500 gallons per hour against a head of 200ft. Another engine of 41 H.P. will assist the turbine at certain periods, and will drive various plants, electric dynamos, &c., when required. There is a laboratory in which constant tests are made by a resident chemist. The plant was put into operation in March last.

Coventry.

By the Coventry Corporation Act of 1928 the Corporation was empowered to carry out certain works for the development of its Water Undertaking at a cost of some £300,000 The works include (*a*) the augmentation of the existing resources by new wells and pumping stations at Watery-lane, Brownshill Green, and Mount Nod; (*b*) the construction of additional storage reservoirs in the Low Level Zone; (*c*) increasing the capacity of the reservoir at Coundon by 9,000,000 gallons; (*d*) the construction in the Middle Level Zone of a new reservoir on Meriden Hill, with a capacity of 10,000,000 gallons, and another at Corley, with a capacity of 800,000 gallons; (*e*) the construction of water towers, each of 200,000 gallons capacity, one in the Middle Level Zone and the other in the High Level Zone; (*f*) the modernisation of the pumping plant at Spon End, Whitley and Watery-lane stations; and (*g*) the laying of 6 miles of trunk mains—27in. to 18in.—10 miles of intercommunicating mains—12in. to 9in.—and other ancillary works. Operations in connection with the foregoing were in progress throughout the year. Work was begun on the Meriden Hill and Corley reservoirs, on the bore-holes at Brownshill Green and Watery-lane, and on the trunk mains, while some 10 miles of intercommunicating mains were laid.

The Derwent Valley.

The second instalment of the works in the Derwent Valley, involving the diversion of the river Ashop, was completed. The original scheme contemplated the construction of reservoirs in the Ashop Valley, but unfavourable geological conditions caused that idea to be abandoned, and the diversion of the river into the main watercourse was substituted for it. A weir which diverts the waters of both the rivers Ashop and Alport, has been built across the former. It is built of mass concrete and its crest is 12ft. above the old river bed. The length of the crest is 600ft. The water is discharged into a watercourse which is designed to carry 117 million gallons per day. It is 2¾ miles long and includes a tunnel, 977 yards long, and a steel pipe syphon. The major portion of the watercourse is uncovered, but the parts which are covered have a waterway 7ft. square. The tunnel has the same cross-sectional area. The syphon, which is 273 yards long, is composed of steel pipes, 6ft. in diameter, with an inside lining of cement mortar. The works, which had been progress since October, 1928, cost in the neighbourhood of £142,000.

Glasgow.

No new constructional works of any importance were undertaken by the Water Department of the Glasgow Corporation during the year. The incidental works in connection with the raising of the level of Loch Katrine were completed and the Loch is now practically at top level—that is to say, about 17ft. above the sill of the outlet tunnels. About 30 miles of pipes of various diameters, principally for the supply of the new housing schemes, were laid during the year.

Liverpool.

Vyrnwy Supply: The Aber Tunnel.—During the year the driving of the Aber Tunnel was carried forward at an accelerated rate. At the inlet end, where a Temple-Ingersoll electric air drill was in operation, the heading was advanced 1151ft., which is the greatest length gained at that heading in any of the seven years the tunnel has been under construction. A start had been made at the outlet end in 1928, and during the first half of 1929 that heading was carried forward by drilling with hand ratchets. In the middle of July, however, a pneumatic plant was brought into operation, and by means of it the rate of progress was considerably increased. The total length driven at the outlet heading during the year was 1414ft., making a combined gain in the twelve months of 2565ft. The total length of tunnel driven to date is 7900ft., or 80 per cent. of the whole.

The Aqueduct.—Steady progress was made with the development of the Vyrnwy Aqueduct. The length of 6 miles of the third pipe line, on the Malpas-Cotebrook section of the aqueduct, which had been begun during 1928, was completed and brought into commission during September, 1929. The new main consists of bitumen-lined steel pipes 42in. internal diameter. The ordinary pipes are in 25ft. lengths with spigot and socket joints caulked with lead wire. The pipes were supplied by Stewarts and Lloyds, Ltd., of Glasgow, the pipe laying contract being let to A. Monk and Co., Ltd., of Irlam. Further contracts were entered into during the autumn for the laying of a length of 5¾ miles of the third pipe line on the next section, namely, between Cotebrook and Norton. The pipes, which are being supplied by Cochrane and Co., Ltd., Middlesbrough, are also of steel, lined with bitumen. A considerable number of the ordinary pipes are being made in 30ft. lengths. The work of pipe laying is being carried out by Lehane, Mackenzie and Shand, of Derby, and the length completed to the end of the year was 2817 yards.

Oswestry Filter Beds.—The construction of the four additional slow sand filters, begun in 1928, was finished. Each of these beds will be capable of filtering two million gallons per day. The total capacity of the plant at Oswestry, which now consists of nineteen beds of the same size, will thus be 38 million gallons per day. The filtering material is now being placed in the new beds, which will be ready for use before

* No. I. appeared January 3rd

next summer. The new beds were built under contract by A. Monk and Co., Ltd.

Londonderry.

The 21-mile aqueduct from Banagher to Londonderry was completed during the year, and the last lengths of pipe were undergoing their final tests during December. When these tests are terminated it will be possible to convey water from the intake works in the Glenedra Valley to the reservoirs on the south-east side of the river Foyle. Tenders were invited for the laying of the duplicate steel pipes under the bed of the tidal river Foyle, which is 1125ft. wide at the point of crossing and up to 35ft. deep. Ball and socket joints are provided at intervals to facilitate laying operations and to allow for settlement after laying. The approaches to the river, including the crossing under the Great Northern Railway, are being constructed by the Corporation by direct labour. The mechanical filters, which are of the air-cleaned vertical type, are under construction. The first instalment provides for the filtration of 3 million gallons per day. The foundations for the Altnaheglish Dam were proved and the site of the dam located. The dam will be of concrete and will have a height of 100ft. above the river bed. The capacity of the reservoir will be 500 million gallons. Plans for this work are now being prepared in the engineer's office.

Manchester.

The weather of February and March made the maintenance of supplies difficult, mainly on account of the formation of ice in the conduits and reservoir outlets. The number of burst mains was surprisingly small considering that the cold attack was the worst since 1895, but house piping suffered severely. The second pipe line from Thirlmere was equipped with a set of four 12in. centrifugal pumps, similar to those which were installed on the first line in 1926. These pumps are driven by direct-current motors, and it is now possible to increase the normal flow—due to gravity only—to any desired extent up to 60 per cent., which requires three pumps to be in action, the fourth being a standby. These motors and pumps, like those of the first instalment, were supplied by Mather and Platt, Ltd. Work on the Haweswater scheme was begun. A contract for a 5¾ miles long works road was entered into with Edmund Nuttall, Sons and Co., Ltd., together with sidings on the L.M. and S. Railway at Shap. This road will connect the railway line—and the main road to Carlisle—with another road, about 4 miles long, which will serve the works and be carried along the whole future length of the lake to Gatesgarth Pass at the south-west end of Haweswater. When this road is completed the existing road on the northerly shore will be closed. A temporary village was laid out and houses, &c., for staff and men are being erected by contract.

Mexborough.

The water supply of Mexborough is obtained from two sources—from borings sunk in the Millstone Grit, and from what are known as the Ludwell Springs. From both sources the water, while of high organic purity, is very hard, that from the borings having a total hardness of 44·7 deg. English, and that from the springs a total hardness varying between 31·9 deg. and 34·66 deg. English. During the year a softening plant operating on the "Permutit" system was put into operation. The plant is designed for a capacity of 20,000 gallons per hour, and it is arranged to operate in six-hour cycles between regenerations of the "Permutit," thus providing a total quantity of 120,000 gallons of softened water between each regeneration. It comprises two units, each consisting of steel cylinders, 8ft. 6in. in diameter by 15ft. long, arranged horizontally. The two units together contain approximately 50 tons of "Permutit," which forms a bed about 3ft. 6in. deep in each shell, the bed being supported on a layer of Silex material. As the "Permutit" process removes all the lime and magnesia from the water, and as it was decided that the water, as supplied, should have 10 deg. of hardness, it was decided that certain quantities of the two waters—bore-hole and spring—in the proportions of one of the former to two of the latter, should be completely softened, and afterwards to blend this treated water with the necessary volume of hard water to give the whole a resultant hardness of 10 deg. Mexborough's was only the second water undertaking to apply the "Permutit" process for the purposes of a public supply, the first being the works of the West Cheshire Water Board at Hooton in Cheshire.

Perth.

The new water supply works for the city of Perth have progressed favourably since we reported upon them at this time last year. The new 12,000,000-gallon reservoir, which had then just been completed, was filled early in 1929 and, hence, could be brought into general operation during the last nine or ten months, and it proved to be a great asset during the protracted dry weather of last spring and summer. The collecting galleries at the new intake, which were partially carried out at the date of our last report, were finished last summer, and the very difficult work of laying the double line of 24in. steel mains across and under the bed of the river Tay, a distance of 800ft., was also completed about the end of July, the temporary gantry work right across the river being quickly removed thereafter, so as to leave a clear passage for the autumn and winter floods. At present, the works are practically closed down, as the little that remains to be done cannot economically be carried out until the river reaches its normal summer flow. It is expected, however, that the work will be completed during the ensuing summer time and the water supply will then be drawn from the new intake on the river Tay, 2 miles above the city.

Rugby.

The works in connection with the new water scheme were completed. This scheme consisted of the making of an impounding reservoir, together with all the necessary subsidiary works, at Stanford, some 5 or 6 miles from the source of the river Avon, which is at Naseby. The reservoir has a top water area of approximately 140 acres, and it contains 250 million gallons, or sufficient for 163 days' supply, at the rate of consumption of 1·5 million gallons per day. The water is conveyed to Rugby over a distance of some 7½ miles, by a 15in. cast iron pipe. Two additional sand filters have also been provided. The cost of the scheme, including the purchase of land, easements, &c., was approximately £150,000.

Sheffield.

Ewden Valley Reservoirs.—The Broomhead and More Hall Reservoirs, which have been under construction since 1914, were formally opened by the Minister of Health, the Right Honourable Arthur Greenwood, on October 11th. The Broomhead Reservoir has a capacity of 1142 million gallons. The concrete trench is 1148ft. in length, with a maximum depth of 158ft., and an average depth of 120ft., and was filled with 33,000 cubic yards of concrete. The puddle wall is 24ft. wide at the base and contains 41,000 cubic yards of material. The length of the embankment is 1000ft., the width at the base is 594ft., and at the top 20ft., while the height above the river bed is 104ft. It is formed of 686,000 cubic yards of earthwork, the outer slope being 2½ to 1 and the inner slope 3 to 1. The discharge tunnel is 1100ft. in length and the section, horseshoe in shape, is 12ft. wide and 10ft. high. The waste weir is 200ft. long and the bywash is formed of forty-eight curved stone steps 50ft. wide. The More Hall Reservoir has a capacity of 476 million gallons. The maximum depth of the trench is 103ft. and 19,000 cubic yards of concrete were used in refilling. The puddle wall contains 20,500 cubic yards of material. The embankment is 820ft. in length and 80ft. in height above the river level. The total quantity of banking material was 354,000 cubic yards, and of stone pitching 176,000 cubic feet. The overflow weir is 264ft. long and the bywash 700ft. in length and 58ft. wide. The works include a service reservoir situated at Wadsley on the city boundary, with a capacity of 10 million gallons, and 11¼ miles of trunk mains of from 36in. to 15in. diameter. The total expenditure incurred amounts to £1,422,343.

Burbage Reservoir.—The Corporation is promoting a Bill in Parliament this session to construct the Burbage Reservoir and works on land acquired from the Duke of Rutland two years ago, and it is its intention to accelerate the construction of the works in view of the substantial assistance offered by the Government towards defraying the cost of the loan charges, and the necessity of augmenting the high-level source of supply, which is now practically exhausted. The reservoir will have a capacity of about 650 million gallons, and the total cost, including catchwaters, service reservoir, pipe lines and incidental works, is estimated at £650,000.

Skegness.

An extension of the Skegness waterworks was completed and put into service during the year. The new works comprise a well, 12ft. in diameter and 125ft. deep, lined with cast iron cylinders for the upper 64ft. and with blue bricks in cement for the lower 61ft. At the bottom of the well a heading was driven to connect with an existing 14in. boring. The bore-tube was plugged and a hole cut in it to admit water to the heading. As the rest level of the water is above the surface, the plug had to stand a head of more than 130ft., or over 56 lb. per square inch. Duplicate sets of pumps were fixed at the bottom of the well, and duplicate sets of surface pumps were installed in the engine house. They are operated by oil engines of 65 B.H.P. The capacity of each set is 27,000 gallons per hour, and the maximum head against which they have to work is 200ft.

The scheme included a reinforced concrete water tower, with a top-water level 100ft. above surface level, and a capacity of 200,000 gallons. This tower, which stands on a circular raft of concrete, 58ft. in diameter, was built in 1926. When its tank was filled with water, the whole structure developed a tilt and had to be emptied. The question of how to rectify the tilt and to stabilise the tower was much discussed during the next three years, and was the subject of reports by three experts. Eventually it was decided to adopt the advice given in the first instance, viz., to drive a circle of interlocking steel sheet piling right round the base to a depth of 32ft. into the glacial clay. First of all, the piles were driven round the half of the site on the side of the tilt. Round the other half were sunk some fourteen borings, 12in. in diameter, and that side of the base was loaded with sand bags and earth to induce movement in the right direction. The work was begun at the end of August last, and in two months the tilt, which had at the extreme point been nearly 28in. in a height of 110ft. was rectified, and the tower had become vertical. It was allowed to come over a few inches further so as to allow for an expected settlement as the piling was being completed, and movement was then arrested by plugging the bore-holes. The remainder of the piling is now being driven, and meanwhile the tank has been nearly filled with water, without, we understand, any movement of the tower having occurred since the bore-holes were plugged. The whole of the work was executed under the advice of Mr. Percy Griffith, M. Inst. C.E., as consulting engineer to the Urban District Council. Mr. Griffith also advised the Right Hon. the Earl of Scarborough when the pumping station was first erected to his designs in the year 1908.

Wakefield.

The extensive Ryburn Valley scheme, powers for which were obtained in 1924, made good progress during the year. It will be remembered that the undertaking includes (*a*) the construction of two reservoirs in the urban districts of Rishworth and Soyland, to be formed by dams respectively 134ft. and 100ft. high above the level of the stream; (*b*) the laying of a pipe line approximately 21 miles in length, consisting of 22in. and 20in. cast iron and steel pipes; (*c*) the building of intake works and river, railway and canal crossings; (*d*) the driving of a tunnel in the urban district of Barkisland some half mile in length; and (*e*) the installation of mechanical filtration plant at Kirkhamgate near Wakefield, designed to filter 2·6 million gallons of water per day. The driving of the Barkisland Tunnel was completed and the tunnel lined with concrete. The inlet and outlet chambers and portals were also finished. The pipe line from the intake works to the tunnel, 3 miles in length, 22in. in diameter, cast iron and steel pipes, was laid and tested. The pipe line from the tunnel to Ardsley Reservoir, consisting of 15 miles of 20in. and 3 miles of 22in. cast iron and steel pipes was also laid. The testing was delayed for some time, but is now practically completed. In addition, a cross connection 3 miles in length, consisting of 15in. to 10in. cast iron pipes lined with concrete, was also laid and tested. This connection is from the old Ringstone Main to the new pipe line. A reinforced concrete balancing tank, capacity 750,000 gallons, was also built at the outlet end of the tunnel. It is designed to regulate the flow from that point to the Ardsley Reservoir, and it comprises orifices from 6in. to 7in. in diameter placed at different levels and discharging into the well at the head of the pipe line, the object being to delay the charging of the main so that the air in the upper portions of the various syphons may escape without shock. The bridges over Sir John Ramsden's Canal, the river Colne at Bradley, near Huddersfield, the L.M. and S. Railway at Warren-street, Dewsbury, and the river Calder at Dewsbury, were completed, and the steel pipes, lined with bitumen, laid over them. Reinforced concrete gauge basins at the outlet end of Ardsley Reservoir, were constructed and fitted with recording instruments. Work on the Ryburn Reservoir, which will be formed by a concrete dam approximately 100ft. in height above the river bed, and is being constructed by direct labour, proceeded satisfactorily. The access road, house and all temporary works were completed. The excavation for the foundations and heel trench was practically finished. The trench was filled under the centre portion of the dam and about 20,000 cubic yards of concrete were placed in the foundations and the lower portion of the dam, which is now about 15ft. above the stream bed level. Boring and grouting for the purpose of rendering the measures below the heel trench and in the wings water-tight is being carried out by the François Cementation Company, Ltd. During the past eight months approximately 6000ft. of bore-holes were drilled by compressed air, the holes being vertical, slightly inclined to the vertical, horizontal, and inclined to the horizontal, some of them being over 200ft. in length and depth, and approximately 700 tons of cement were injected under a pressure of twice the static head from the top water level of the reservoir. The dam above ground level is being faced with granite concrete placed simultaneously with the gritstone concrete hearting, the surface being subsequently dressed with pneumatic tools, the final effect being that of axed granite. The estimated cost of the whole scheme is £960,000, while that of the works now in hand is about £600,000.

Works Completed, in Progress, or in Contemplation.

Excavation of the trench for the Silent Valley Dam for the water supply of Belfast was continued and completed, a satisfactory foundation having been obtained, and the placing of concrete was begun towards the end of the year. Kingsbridge and Salcombe agreed to form a Joint Water Board for the carrying out of a scheme to supply the two towns with an additional supply from a source on Dartmoor, at an estimated cost of £40,000. Warrington decided to

promote a Bill for sanctioning the construction of works to abstract water from the river Mersey for trade purposes. The cost of the scheme is estimated at £54,000. A scheme for the purification and supply of water in the districts of Pontnewydd and Cwmbran, to cost eventually £50,000, was planned. Bognor Regis dete mined to buy the undertaking of the local Water Company for the sum of £74,653. The Windermere Urban District Council had under consideration the purchase of the Windermere District Gas and Water Company, at a cost of £74,000. Dundee had in hand a scheme for improving its water supply at a cost of upwards of £30,000. Preston received sanction to borrow £27,417 for a water supply undertaking. Leicester decided to spend upwards of £40,000 on a new filtration plant. Penz nce is improving its supply at a cost of some £25,000. A scheme to afford supplies to Blackwell, Warsop and Skegby at an estimated cost of £165,000 is in hand. The Colwyn Bay and Conway Joint Water Board had under consideration the provision of new reservoirs and the laying of additional mains, at a cost of some £100,000. The laying of the 10-mile main between the new catchment area at Fernworthy to the reservoir at Tottiford of the Torquay Corporation was completed. The Dumfries Council decided to apply for a Provisional Order for powers to carry out a scheme to include the laying of a trunk main 5 miles long, at an estimated cost of £100,000. Derby completed a 3,000,000-gallon service reservoir which had cost £23,000. The Bath City Council had before it a water supply scheme involving an expenditure of £298,000. The proposals include the construction of a reservoir to contain 300 million gallons. Barnsley completed the construction of a reservoir to contain 160 million gallons, and was engaged on further works. Stockport applied for powers to construct two reservoirs, one to contain 900 million gallons and the other 800 million gallons. Hull considered a very extensive scheme estimated to cost £1,000,000. The Durham County Water Board, in conjunction with the Sunderland and South Shields Water Board, have in view the construction of a dam in Weardale at a cost approaching £900,000. A scheme which is being considered by Carlisle with a view to improving the pressure in certain parts of the district, involves additions to its filtration plant, and is to cost some £62,600. A new pump capable of delivering 9 million gallons of water per day to Southend from the river Blackwater was put in service. The new water supply for Chard which has been in progress for the last couple of years was completed. The Tees Valley Water Board decided to apply to Parliament for powers to carry out developments, at a cost of £618,000. Nantwich Rural District Council approved a provisional estimate of £115,000 for new water supply works. Leeds completed the construction of a million-gallon service reservoir, and was engaged on the construction of another to hold 1¼ millions. Chesterfield completed new filter works to deal with 29 million gallons a day, and laid 8 miles of new 12in. main to convey the water to Staveley. The South Essex Waterworks Company, in connection with the extensive scheme on which it is engaged, let contracts for pipes and valve, pipe laying, pumping machinery, and the construction of two covered reservoirs. It also had in hand the construction of an open sedimentation reservoir. Preliminary work was begun in connection with the construction of the dam at Talybont in Breconshire, which is to impound 2500 million gallons for extending the supply of Newport, and which will, it is estimated, cost half a million of money. A scheme for the joint supply of West Dean and Coleford, involving the construction of a pumping station, reservoirs, and a water tower, and the laying of some 38 miles of mains, at a cost of about £55,000, was in progress.

Bore-holes.

The year again witnessed the sinking of numerous bore-holes. In the metropolitan area alone some thirty-three, varying in depth from 300ft. to 700ft., were put down by Messrs. Islers alone, the aggregate depth amounting to nearly 17,000ft. These bore-holes varied in diameter from 6in. to 18in., while the supplies drawn from them range between 500 and 20,000 gallons per hour. The same firm was during the same period also engaged on the following bore-holes at various places in the provinces; in each case the diameter and the depth of the bore-hole are added in brackets:—Retford (30in., 650ft.); Ross-on-Wye (20in., 100ft.); Tonbridge (12in., 67ft.); Dagenham (15in., 445ft.); Northfleet (10in., 885ft.); West Hartlepool (20in., 250ft., and 18in., 260ft.); Sunderland (12in. 241ft., and 12in., 288ft.); Collyhurst, Manchester (20in., 355ft.); Liverpool (30in., 688ft.); Halifax (11in., 1650ft.); Barrow (5in., 256ft.); Keighley (6in., 280ft.); Widnes (15in., 350ft.); Saltley (12in., 800ft.); Witton (15in., 400ft.); Birmingham (15in., 360ft.); and Aston (10in., 400ft., and 12in., 400ft.).

Athens.

What is known as the Marathon Dam, which has been built for increasing the supply of water to Athens by an American company, at a cost, it is said, of some £2,500,000, was formally opened on October 25th last, in the presence of President Conduriotis. Actually, however, we understand that Athens has not as yet received any water from this new source, though we believe that it will very shortly do so. The structure, which contains some 175,000 cubic metres of masonry, and has the unusual feature of being of white marble, has been built on the hill of Turkovorini—a foothill of the Parnes Mountains—some 14 miles from the city. The reservoir formed by it will have a capacity of some 41 million cubic metres—say, 9,000,000,000 gallons of water. According to *The Times*, the engineers have been able to make use of the aqueduct which the Emperor Hadrian began to build about the year A.D. 130.

Heightening the Aswan Dam.

The Report of the Technical Commission, which was appointed by the Egyptian Government in November, 1928, to inquire into and report on the feasibility of raising the Aswan dam in order to impound an additional volume of water, was delivered so expeditiously that it was made public early in February last. Briefly stated, the proposals made in the Report were (*a*) that the vertical portion of the existing dam should be raised to the required height, by adding an additional 9 m., the existing width of roadway being retained; (*b*) that buttresses, varying in width, should be constructed on the downstream side between each pair of sluices, the buttresses projecting from the existing structure for a distance of 6 m. at a level of R.L. 87·50, diminishing to 1 m. at the level of the existing roadway; and (*c*) that the existing buttresses should each be strengthened by the addition of a new buttress of the same width conforming in all other particulars with those between the sluices. The proposed new buttresses were to have no fixed contact with the existing masonry, and were to rest on wrought iron non-corrodible bearing plates, 7 mm. thick. The members of the Commission were:—Mr. W. J. E. Binnie, M. Inst. C.E., as representing Great Britain; Mr. Hugh L. Cooper, as representing the United States; and Dr. H. E. Grüner, as representing Switzerland. We understand that the proposals of the Commission were adopted and that a beginning was made during the year with the work of carrying them into effect.

Canada.

Calgary, by a plebiscite in which 4274 votes were cast against 2595, decided to adopt a new waterworks system which is to cost 3,770,000 dollars—say, £750,000. The proposal includes the construction of a reservoir on a 900-acre site which would impound a volume sufficient for the supply of a population of 200,000 people. The Administrative Committee of the City of Quebec decided on the construction of a reservoir to contain 30,000,000 gallons at a cost of some £200,000. Toronto invited tenders returnable in December for the construction of intake and filtered water tunnels for its additional water supply. Ottawa has in hand a scheme for installing a water purification plant at a cost of 1,315,000 dollars.

France.

Apart from the construction of new filtering beds at Saint-Maur for the Paris water supply and the carrying out of a few minor works in the provinces, nothing of much importance was done during the year. Nevertheless, it was a year of great activity in the preparation of new schemes. The growth of urban population has raised problems which are being dealt with in the new programmes of municipal works. In some cases, as at Nice, the water will be brought from reservoirs fed by streams, and in others, as at Tours, new wells are being sunk to the subterranean water in the Vals de Loire. In the latter case there is difficulty in pumping water free of sand. For that reason Lyons is hesitating between sinking new wells and taking water direct from the Saône and Rhone. The trouble does not deter the Paris water engineers, who regard the Vals de Loire as offering the only available source of supply which will provide the city with ample reserves for practically all time. For the moment the new filtering beds at Saint-Maur and Ivry have placed Paris beyond the risk of shortage, except during periods of prolonged drought, and as every possible source is now utilised and Paris is drawing the maximum from the Marne, the only hope of covering future requirements lies in the Vals de Loire. During the year a scientific commission was engaged in investigating the objections of the local populations who fear that the Paris scheme will have serious consequences for themselves, and the carrying out of the proposal will depend upon the commission's report. Of still more immediate importance is the decision of the Government to put in hand a vast scheme of rural water supply at a cost of something like 300 million francs. Very little has been done so far to provide small towns and villages with water, and during the summer months many districts often suffer from a serious shortage of water. A technical commission has been at work advising rural authorities upon the best means of utilising the resources at their disposal.

The Nag Hammadi Barrage.

The construction of the new barrage across the Nile at Nag Hammadi, the contractors for which are Sir John Jackson, Ltd., and the engineers Messrs. Coode, Wilson, Mitchell and Vaughan-Lee, was continued during the year. There are, in all, to be 100 openings in the barrage, and ten of them, together with the lock on the west bank of the river, were practically completed in 1928. The programme proposed for 1929 was to construct the floor of the barrage for a further fifty openings and to build the piers and superstructure thereon, and that programme was carried out, notwithstanding the advent of an early flood about three weeks before the usual date. The temporary dam around the season's work was completed on January 5th, and the enclosed area was unwatered by January 21st. Excavation was at once begun and the concreting and masonry of the main floor of the barrage, which was started about the middle of February, was continued unceasingly until its completion about the end of May. In the meantime, the fifty dressed masonry piers were under construction, work on them having been begun in the third week in March. The last pier of the season's work was practically completed by the middle of July, after the work had been brought above the level of the water which was allowed to flood the enclosed area on June 26th. The time available for work inside the temporary dam was only five months, during which time some 80,000 cubic metres of excavation were effected, 3250 tons of steel piling were driven, and about 113,000 cubic metres of mass concrete, concrete blocks, rubble masonry, dressed stone, &c., were placed in position. After the arrival of the annual Nile flood in July, work on the superstructure and arches was continued during the period of high river level, until, at the end of the year, the masonry work of the barrage had practically been completed for three-fifths of the way across the Nile. The lock gates and swing bridge across the lock were put in position by Sir William Arrol and Co., Ltd., and the lock was opened for river traffic. Ransomes and Rapier, Ltd., placed thirty sets of sluice gates in position in the barrage and erected the two power-driven operating machines for manipulating the sluice gates. During December preparations were made for the 1930 season's work, and the driving of the steel piles for the temporary dam was begun.

Other Places Abroad.

It was decided during the year to proceed with a scheme for taking water from tributaries of the river Delaware to increase the water supply of New York. The proposal, it is reported, will provide an additional 700 million gallons a day and will cost some 273 million dollars. Both Port Elizabeth and Stellenbosch decided to install water meters in all supply services. A pipe line to convey water to Cedar City, Utah, was laid by hanging the pipe on the side of Bryce's Canyon, some 600ft. above the bottom of the gorge. The pipe was taken to the site piece by piece and was welded together in place. It is a 12-gauge, butt-welded, ingot iron pipe, 10in. in diameter and 34,400ft. long. It has a total fall of 1234ft. Pretoria had under consideration a scheme to increase its water supply to 10,000,000 gallons a day at a cost of some £800,000. It was proposed to replace the masonry culverts of the New Delhi waterworks between Idgak and Talkatora by steel pipes. This work, which is to cost 2,83,000 rupees—say, £21,200—is necessitated by contamination of the water supplies. The Municipal Council of Toulon decided to increase the town's supply by constructing a barrage across a valley in order to store water from a torrent known as the Lateil. The proposal met with much opposition from local agriculturists on the ground that the proposal would seriously injure their interests; but the Council won its case before the law courts, though it is required to make good any damage that may be caused. The standing—central section—of the St. Francis Dam, the failure of which was referred to in our last Annual Article, was demolished by blasting during the summer. The concrete mass was some 180ft. high by 90ft. wide and 108ft. thick at the bottom. About 3¾ tons of dynamite were employed for the demolition. Nagpur decided to augment its supply of potable water by pumping from the river Kanhan. The scheme involves the laying of a pipe line some 12 miles in length and will cost about 28 lakhs of rupees.

The Vernon Hooper Reservoir at Shonweni, which was completed some eighteen months ago, for increasing the water supply of Durban, does not appear to be providing the volume of water which it was expected to furnish. The scheme was expected to yield 20 million gallons a day, but ever since the undertaking was put into commission the catchment area—which extends to 312 square miles—has suffered drought conditions. During the year the Borough Water Engineer, in a report surveying the position, stated that the daily quantity of water which could have been relied upon could not have been more than 13 million gallons. It is asserted locally that the reservoir has been formed in the wrong watershed.

On August 26th the Governor of Bombay, Sir Frederick Hugh Sykes, opened the Visapur artificial lake and canal system which have been under construction for many years. The scheme comprised the formation of a lake with a water spread of 2½ square miles, which was effected by means of an earthen dam 7440ft. long at the crest and 84ft. high above the river bed, with a waste weir 1960ft. long. The volume of water impounded is 1218 million cubic feet. The main canal which leads the water from the reservoir is designed to discharge a maximum of 110 cusecs. Water is distributed to the fields through 35 miles of distributaries and minors and 157 miles of cultivators'

SOME MARINE OIL ENGINES OF 1929

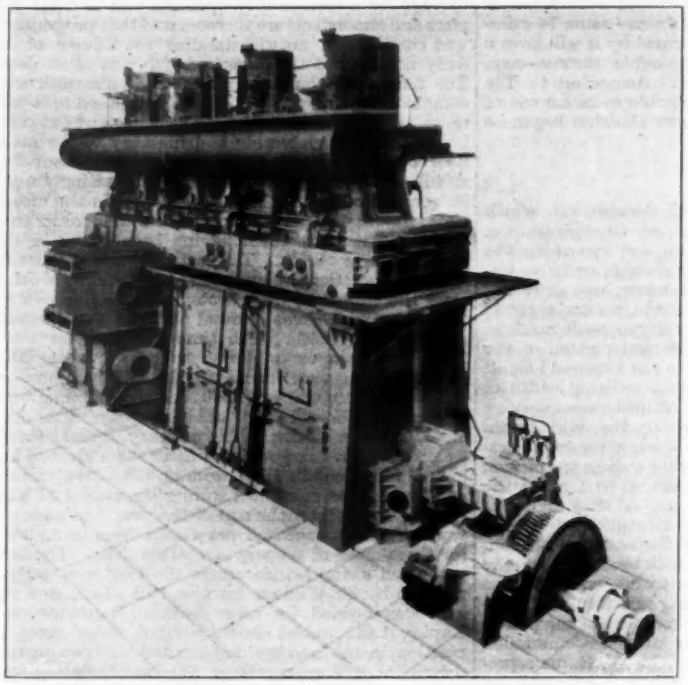


FIG. 8—2900 S.H.P. DOXFORD OPPOSED-PISTON ENGINE

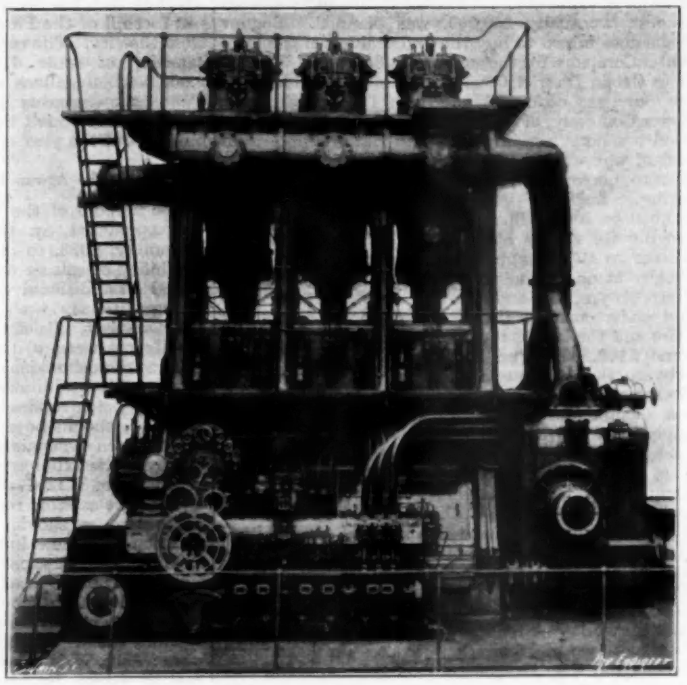


FIG. 9—1250 S.H.P. RICHARDSONS-WESTGARTH DOUBLE-ACTING ENGINE

channels. Another irrigation project was advanced a stage during the year by the completion of a dam across the river Lerma, near Tepuxtepee, in Mexico. This dam will impound 500,000,000 cubic feet of water, which is to be used to irrigate 100,000 acres of arid land. It cost some 10,000,000 dollars to build. During the year, too, the Chilean Government allocated £4,000,000 for irrigation projects and considered plans for irrigating portions of the nitrate region extending to 60,000 acres by the construction of extensive works. A large irrigation dam known as the Owyhee Dam, across a river of that name in Oregon, was under construction by the United States Government Irrigation Service. This dam is to be 405ft. in height at its maximum section and 520ft. from the lowest point of its concrete cut-off wall. Very many other irrigation projects were in progress throughout the world.

The Nile Water Regulation Agreement.

The negotiations between the British and Egyptian Governments on the subject of the use and control of the Nile waters ended in an agreement, formal letters having been exchanged at Cairo on May 7th between Lord Lloyd and the Prime Minister of Egypt. The works covered by the agreement include the Aswan Dam, the Makwar Barrage on the Blue Nile, the projected Tana Barrage in Abyssinia, the Gebel Aulia Dam on the White Nile, a proposed canal through the Sudd region, and the projected dam at the outlet of the Albert Nyanza Lake. Under the agreement both parties, it is understood, are free to construct works and to apply measures for increasing their water supplies from the Nile, its tributaries and lakes. In the case of works undertaken by the Sudan there is provision for the protection of Egyptian interests, the agreement recognising, on the one hand, that the Sudan requires more water than at present for its development; and, on the other hand, that Egypt has natural and historical rights in the waters of the Nile.

Motor Ships and Marine Oil Engines in 1929.

No. II. (*conclusion*).*

Types of Propelling Machinery.

Four-stroke "Werkspoor" Type Engines.—On page 27 of our last issue we illustrated in Fig. 5 a four-stroke single-acting engine of the "North-Eastern-Werkspoor" type, constructed for the two twin-screw motor cargo ships "Penrith Castle" and "Thurland Castle," belonging to the motor ship fleet of the Lancashire Shipping Company, Ltd. The design incorporates some improvements, but is generally in keeping with the makers' standard practice. Each unit has a designed output of 4480 S.H.P. at 110 r.p.m., and there are six cylinders with a bore of 730 mm. and a stroke of 1500 mm. Air injection is employed and the air compressor is mounted at the forward end of the engine. All the principal castings are made from "Perlit" iron. On the full load trials of the engine a fuel consumption of 0·404 lb. was obtained. The engines referred to are identical with those installed in the two sister ships "Greystoke Castle" and "Muncaster Castle," which have been in service for over a year in the owners' New York–Far East trade. The average returns from four round-the-world voyages show a mean consumption of 0·305 lb. of oil-fuel per I.H.P. hr., or 18 tons of oil per day for all purposes with a mean speed of 13·47 knots and at a mean displacement of 12,350 tons.

Among some other interesting engines built by the North-Eastern Marine Engineering Company, Ltd., were two for Alfred Holt and Co., which were constructed to the owners' requirements and to their specification. They will be installed in the Blue Funnel motor liner "Maron," which was recently launched at Dundee by the Caledon Shipbuilding and Engineering Company, Ltd. The engines follow generally N.E.M.-Werkspoor practice, but they embody many new features, such as oil-cooled pistons and fuel pumps for each cylinder. They are also specially designed to work with Brown-Boveri exhaust turbo-blowers on the Büchi system of pressure charging. The exhaust gas passages and the inlet passages to the turbine are so designed that the exhaust temperature rises between the engine cylinders and the turbine unit. The engines are of the six-cylinder air injection type, with a bore of 620 mm. and a stroke of 1300 mm., and they are designed to run at about 138 r.p.m., giving an output of about 2750 S.H.P. supercharged and 1880 S.H.P. when running unsupercharged. The gain in output obtained by pressure charging is about 50 per cent., which enables a smaller engine to be employed with a corresponding saving in engine-room space. Some test figures may be quoted. When running at 2750 S.H.P. and 138 r.p.m. and the blower running at 4800 r.p.m., with an exhaust pressure of 4 lb. per square inch, the charging air pressure was 5 lb. per square inch. The average exhaust gas temperature was 740 deg. Fah. at the cylinder and 920 deg. Fah. at the turbine inlet. Complete bench trials were carried out on one of the "Maron" engines by Professor C. J. Hawkes, of Armstrong College, Newcastle-upon-Tyne, and it is hoped that at a later date, with the permission of Alfred Holt and Co., some further particulars as to the service performance of these engines compared with those of standard construction without pressure charging may be given. Propelling machinery of a similar type to the "Maron" engine is being built at Scotts Shipbuilding and Engineering Company, Ltd., Greenock, for motor ships of the Blue Funnel Line, which are now being built at Greenock.

Two-stroke Sulzer Type Engines.

Among the two-stroke single-acting motors of the Sulzer type which were built on the Clyde and Tyne during 1929, prominence, on account of their large diameter cylinders and output, must be given to the engines built at Clydebank by John Brown and Co., Ltd., for the three liners of the "Rangitiki" class completed for the New Zealand Shipping Company, Ltd. The starboard unit of one of these vessels was shown in Fig. 6 on page 27 of last week's issue. The horse-power of 9300 S.H.P. given in the title under the block refers, as shown in Table II., to the total S.H.P. developed in service, and the rated horse-power of each engine is half that amount, namely, about 4650 S.H.P. Over 5000 S.H.P., however, was developed under trial conditions. The cylinder diameter of 35 $\frac{7}{16}$ in. and the output of over 1000 S.H.P. per cylinder on trial, which shows the suitability of the two-stroke single-acting engine for large powers is noteworthy.

Particulars of other Sulzer engines were also given in Table II., and they include several sets of machinery constructed by William Denny and Bros., Ltd., and the Wallsend Slipway Company, Ltd. At Govan the Fairfield Shipbuilding and Engineering Company, Ltd., completed twin-screw machinery of 7700 S.H.P. output for the Bibby liner "Staffordshire," and work was begun on engines for a sister ship. An important order of the year was that of the "Tuscan Star," which was launched by Palmers Shipbuilding and Iron Company, Ltd., on the Tyne, and will be equipped with twin-screw Sulzer engines of 12,000 I.H.P. output which are being built at Winterthur. At Wallsend some two-cycle single-acting engines of the Atlas-Polar type were constructed by Swan, Hunter and Wigham Richardson, Ltd., for the British oil-tanker "Oil Reliance."

Two-stroke Doxford Opposed-piston Engines.

A feature of the year's returns was the increase in the number of vessels propelled by opposed-piston engines of the Doxford type. The engine works of William Doxford and Sons, Ltd., were well employed and are now filled for some time ahead. More than six sets of engines were completed at Sunderland, while others were built under licence by Richardsons, Westgarth and Co., Ltd., at West Hartlepool, and Barclay, Curle and Co., Ltd., at Glasgow. We illustrate in Fig. 8 one of the latest balanced type four-cylinder units recently constructed for the 12-knot cargo ships "Fresno City" and "Vancouver City" of the Reardon Smith Line. The cylinder bore is 600 mm. with a stroke of 980 mm. for the upper piston and 1340 mm. for the lower piston. The designed output is 2900 S.H.P. at 92 r.p.m. It will be noticed that the scavenge pumps are driven by levers from the second cylinder. The fuel pump unit will be seen at the fly-wheel end of the engine, along with a neat design of electrically operated barring gear.

A very interesting paper on "Opposed-piston Oil Engines," in which much information concerning the Doxford opposed piston engine, is to be found, was given by Mr. J. Harbottle, Lloyds' Surveyor at Sunderland, before the Institute of Marine Engineers on November 12th last. The author referred to recent figures for fuel consumption, which are of the order of 0·36 lb. per S.H.P.-hour, with lubricating oil consumption of from 3·3 to 4·25 gallons per 1000 S.H.P. per day for main engines only. One of the features of the North-East Coast Exhibition was a three-cylinder Doxford engine of 1000 S.H.P., which was exhibited in motion and will be erected in a ship. A description of this engine will be found in our issue of May 24th, 1929.

A British Two-stroke Double-acting Engine.

Few engine developments of recent years have been followed with more interest than that of the Richardsons, Westgarth double-acting two-stroke engine designed by Mr. W. S. Burn. In our issue

* No. I. appeared January 3rd.

of March 8th we described the three-cylinder 1250 S.H.P. unit, which, during the year, saw sea service in the oil-tanker "Irania." The engine—see Fig. 9—is remarkable for the original way in which fuel injection and scavenging air problems are dealt with. In the course of a paper read before the North-East Coast Institution of Engineers and Shipbuilders, in November last, the designer of the engine gave a full account of the development which has taken place since the construction of the first experimental unit, and the performance of the engine at sea. It was satisfactory to learn that the results of the voyages made with the "Irania" had fulfilled in every way the builder's expectations.

Methods of Scavenging and Supercharging.

An important branch of marine oil engine work in which distinct progress was made in 1929 was that relating to new methods of scavenging and supercharging. The supercharging blower designed by Mr. W. S. Burn for the Richardsons-Westgarth double-acting engine is shown in Fig. 9, to the right of the illustration. It marks a departure from previous practice and it proved economical and silent in

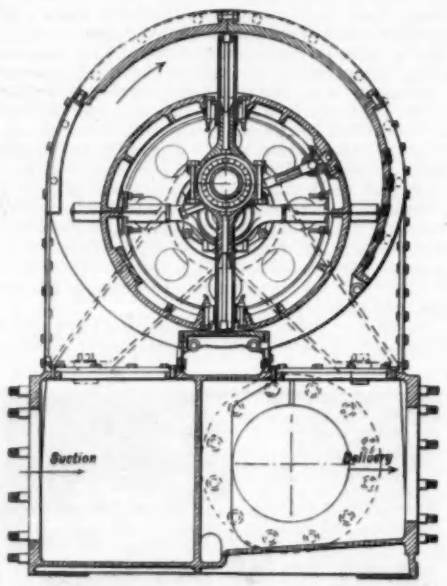


FIG. 10—POWERPLUS SCAVENGING BLOWER

service. It consists of horizontally opposed twin scavenge pumps, which eliminate the out-of-balance forces usually associated with direct-driven scavenge pumps. The delivery of the air is timed by positively driven rotary suction and discharge valves, and the air passes through the pump from the silencing arrangement in the bed-plate to the scavenge main with a uniflow action. The normal scavenge air pressure used on the "Irama" is 1·3 lb. per square inch, and in the latest design of pump a swept volume of 40 per cent. in excess of the cylinder volume is employed.

A new supercharging and scavenging blower of British design was that designed and constructed by Powerplus (1927), Ltd., of 508, High Holborn, is shown in Fig. 10. As the drawing indicates, there are four blades or vanes, which by mechanical means are made to follow the contour of the blower casing, which is excentrically placed with respect to the driving shaft. The vanes are reciprocated by a series of cranks, and they move in specially lubricated guides which are connected to the forced lubrication system. The air is drawn in and discharged in the usual vane pump manner. The section we show illustrates a blower specially designed to supercharge a 600 B.H.P. Diesel engine. The volumetric efficiency of the blower is about 75 per cent. and the adiabatic compression efficiency 79 per cent. when running at 960 r.p.m. and delivering 2100 cubic feet of free air per minute at a discharge pressure of 5 lb. per square inch. The blower is reversible and may be driven either directly from the engine through bevel gearing or by a separate motor. The maximum duty of the blower referred to is 3000 cubic feet of air per minute and a 5000 cubic feet blower is also under construction. In Fig. 11 we show a Brown-Boveri exhaust gas turbine driven blower with the upper cover removed so as to show the turbine and the blower impellers. The unit illustrated is generally similar to that employed on the "Llangibby Castle" in connection with the Büchi system of supercharging. On the Holt liner "Agamemnon" a similar arrangement with "Rateau" type blowers was employed.

In connection with the new design of Burmeister and Wain double-acting two-stroke engine a novel type of rotary blower has been perfected, a section through which is given in Fig. 12. It differs from other rotating

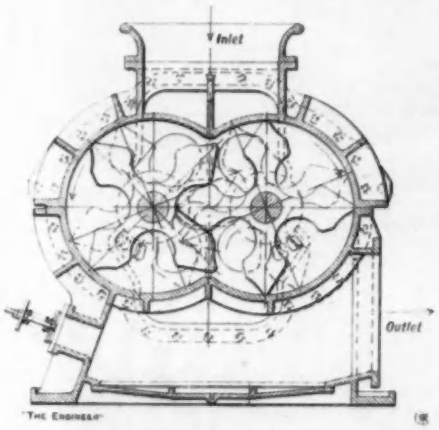


FIG. 12—B. AND W. ROTARY SCAVENGE BLOWER

blowers in the shape of the teeth, which are designed to allow the inlet and outlet for the air to take place longitudinally through the rotors with connections on the ends of the blower casing. Experiments were made on the silencing of the blowers by adopting different running speeds, and quiet running was achieved with peripheral speeds below 49ft. to 52ft. per second. In rotary blowers of this type which have been built for a ship belonging to the East Asiatic Company, the rotor diameter is about 27 $\frac{9}{16}$ in. corresponding to a peripheral speed of about 47·5ft. per second. The blower is suited either for electric or direct drive from the engine.

The drawing reproduced in Fig. 13 is a sectional view of the Werkspoor scavenging system as applied to single-acting four-stroke engines of the Werkspoor type installed in the Anglo-Saxon Petroleum Company's tanker "Megara." The ends of the working cylinders are completely enclosed by a light aluminium casing in which three suction and three delivery valves are arranged vertically. With this system in operation the original output of 2850 S.H.P. was increased to a continuous supercharged output of 4000 S.H.P.

In two other continental types of engines, namely, the Krupp two-stroke single-acting engines and the new Tosi two-stroke single-acting engine, individual

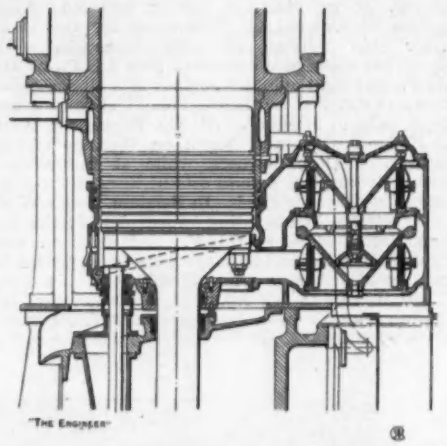


FIG 13—WERKSPOOR SUPERCHARGING ARRANGEMENT

scavenge pumps for each two and in the latter case for each cylinder are employed.

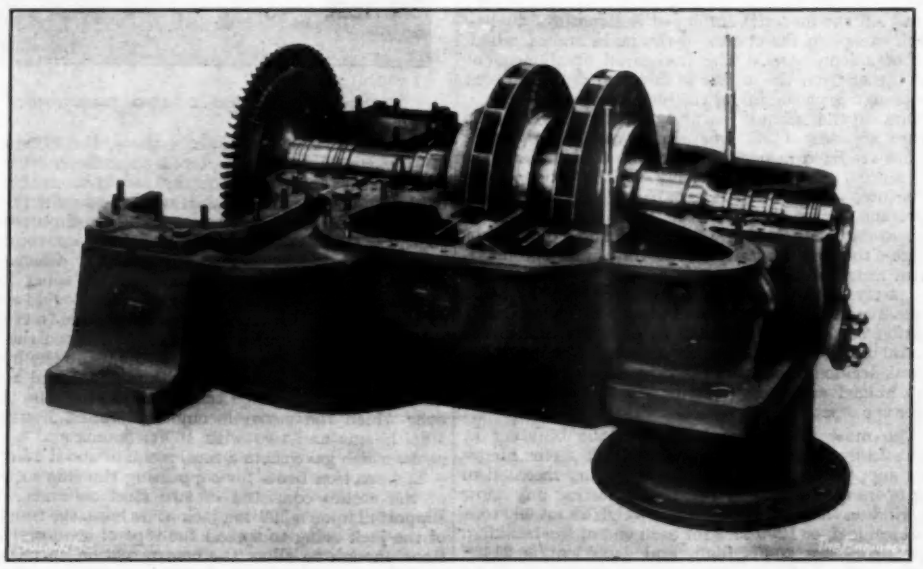


FIG. 11—BROWN-BOVERI EXHAUST GAS TURBINE DRIVEN BLOWER

Auxiliary Oil Engines.

There was considerable activity in the building of British auxiliary oil engines in 1929, and several new types and sizes were put on the market. At Bedford, W. H. Allen, Sons and Co., Ltd., completed thirty-five sets of engines, ranging in output from 100 B.H.P. to 675 B.H.P. in two to six-cylinder units. At Stockport, Mirrlees, Bickerton and Day, Ltd., supplied twenty sets of auxiliary engines, while Belliss and Morcom, Ltd., completed several sets for Blue Funnel Line ships. The Ruston-Hornsby units supplied to the "Dunster Grange" and sister vessels continued to give good service, and several sets of auxiliary engines of this type were supplied during the year and are in hand for new motor ships.

At Glasgow some large auxiliary generator and air compressor sets were completed for the Prince Line motor ships by Fiat British Auxiliaries, Ltd. An interesting new auxiliary engine of the Brotherhood-Ricardo type—see THE ENGINEER, February 22nd, 1929—was constructed by Peter Brotherhood and Co., Ltd., of Peterborough, and in our issue of February 15th we described a new light-weight engine of the four-stroke high-speed type designed by Vickers-Armstrongs, Ltd., of Barrow-in-Furness.

Gardner and Sons, Ltd., of Patricroft and London, also supplied several sets of oil engines for main propulsion and auxiliary service, and particulars of the new series of cold-starting engines were given in our issue of January 18th, while a typical installation of Gardner engines in the Thornycroft-built motor yacht "Rosa" was described in THE ENGINEER for September 13th.

At Southampton the Parsons Oil Engine Company, Ltd., constructed several sets of engines both for emergency lighting service and for motor lifeboat propulsion, and a description of the latest type of Parsons marine oil engine was given in our issue of March 15th.

General Progress Abroad.

Considerable activity in motor shipbuilding was displayed in both Denmark and Sweden, and in each of these countries over twenty motor ships were completed, most of them being fitted with Burmeister and Wain type engines. An event of the year was the construction of an entirely new design of double-acting two-stroke engine by Burmeister and Wain, Ltd., which will be installed in one of the new ships of the East Asiatic Company. The cylinder has the usual central scavenge ports, but at either end there are centrally placed mechanically operated exhaust valves, which give a through scavenge. The valves are operated from a lay shaft on the base plate through rocking levers. In connection with this new engine the rotary scavenge blower, already referred to and illustrated in Fig. 12, was designed and tested.

In Germany about twenty motor ships were completed, and they included several equipped with M.A.N. type engines. Two interesting ships were the 17,000-ton "St. Louis" and "Milwaukee," which were equipped with geared M.A.N. double-acting two-stroke engines. A new type of double-acting two-stroke engine, designed by the Deutsche Werke, was also installed in two fast cargo ships, the "Sud Americano" and "Sud Expreso." Very successful results were obtained with A.E.G. engines of the two-stroke double-acting Hesselman type fitted to Hamburg-America Line cargo ships. An account of progress with the M.A.N. two-stroke double-acting oil engine will be found in our issue of June 28th, 1929. In Switzerland, Sulzer Bros. completed at Winterthur sixty-three propelling engines, totalling 73,500 I.H.P., and 10,500 I.H.P. of auxiliary engines. Towards

the end of the year it was announced that the first two-stroke double-acting Sulzer engine would be installed in a Dutch steamer and that it would be an eight-cylinder unit with 700 mm. bore cylinders with a designed output of 7000 S.H.P. at 106 r.p.m. In Fig. 14 we illustrate one of two ten-cylinder engines constructed at Winterthur for the Dutch motor ship "Johan van Oldenbarnevelt." The engine has a designed output of 7040 S.H.P., or 9325 I.H.P., and eight-cylinder engines of a similar power were also supplied for three "Polau" class fast cargo ships built in Holland. At the Werkspoor Works in Holland work was begun on Werkspoor-Sulzer engines for Dutch owners, while at Burgerhout's yard at Rotterdam several sets of Burgerhout-Nobel engines were constructed. In Belgium, Carels Works constructed a double-acting two-stroke Worthington type engine of 4000 B.H.P., and work on some Carels-Ingersoll-Rand engines for electrical propulsion was begun. A new type of engine of this design of 400 B.H.P. at 265 r.p.m. is to be installed in a Thames tug now under construction at Thornycrofts' Southampton yard. In the course of our descriptions

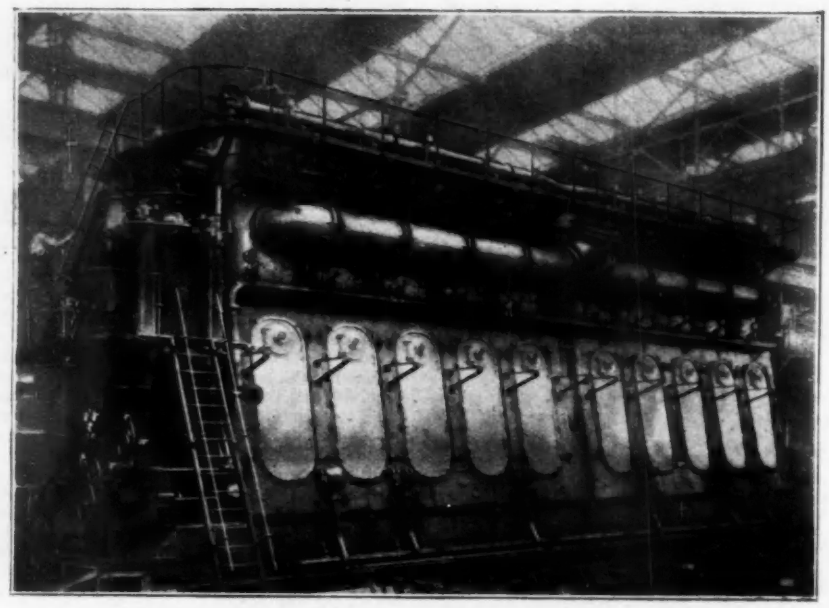


FIG. 14—7040 S.H.P. TEN-CYLINDER SULZER ENGINE

of Italian works at the time of the visit of the Institution of Naval Architects to that country, we mentioned the progress which was being made in oil engine construction at the Trieste, Fiat and Ansaldo works. At Legnano, Tosi Bros. completed nearly twenty sets of machinery of the two-stroke and four-stroke types for Italian motor ships, and a new two-stroke single-acting engine was produced. In both France and Spain progress in motor shipbuilding was made. In the course of our recent descriptions of Japanese engineering works we described some of the new Pacific liners built in Japan and engined with Burmeister and Wain and Sulzer type engines. Work in America was mainly confined to the conversion of steamships to motor ships and engines of several standard American types were fitted.

The Goodyear Zeppelin Airship Shed at Akron, Ohio.

THE airship factory and dock now approaching completion at Akron, Ohio, to which brief reference was made in our issue of January 3rd, is intended for the construction and housing of two super-Zeppelins which are being built by the Goodyear Zeppelin Corporation for the United States Navy. These airships will have a length of 785ft., a diameter of 134ft., and a helium gas capacity of 6½ million cubic feet, and will be the largest airships so far built. The shed, however, has been designed to house an airship considerably larger than these vessels. The building is remarkable not only on account of its size, but also because of its shape, the method of closing the ends and the system of construction. Its size may best be judged by the following comparative table, all figures in which are in feet :—

	Akron.	Lake-hurst.	Fredrich-schafen.		Karachi.	Orly. France.
			1st	2nd		
Length ..	1175	803	603	787	850	984
Width ..	325	264	150	150	230	298
Height ..	197	172	65	114	170	194

The floor area of the Akron shed is 364,000 square feet, and is by far the largest single uninterrupted floor area yet covered.

All of the previously built airship sheds mentioned in the above table have vertical doors opening horizontally, but much smaller sheds have been built in Germany of design similar to that adopted at Akron. This design of door was decided on after extensive tests on models which demonstrated the superiority of the form adopted as regards the resistance offered to wind currents. The shape of the building is semi-paraboloid; that is to say, sections taken across it form parabolas, and its longitudinal section also forms two half-parabolas connected by a straight line. As the launching or docking of an airship cannot safely be carried out against a wind greater than a certain maximum for each case, the great importance of eliminating locally increased currents will be readily understood. For example, if an airship such as the "Graf Zeppelin" cannot be docked at the Lakehurst shed against a cross-wind velocity of 10 miles per hour, because the local currents are as high as 20 miles per hour, and another type of door can be used which causes no increased local currents, the usefulness of the shed itself is practically doubled. It is this factor which determined the use of the semi-spherical, or "orange-peel," type of door at Akron.

In general, the structural design of the shed involves eleven parabolic arches spaced 80ft. apart, centre to centre, and connected by a system of vertical and horizontal trusses. In addition to forming the bracing system for the structural shell, these trusses carry light trussed rafters spaced at 10ft. centres and carrying Z-bar purlins at 8ft. centres. At each end of the main shell are placed two diagonal arches, meeting the end arches at the door pins, which are 800ft. apart. The doors are built up of similar arched and braced ribs. All the material employed is structural quality steel, except in the chords of the main arches, which are of silicon steel. The horizontal component of the thrust from the arches is taken up by reinforced concrete ties placed under the building floor.

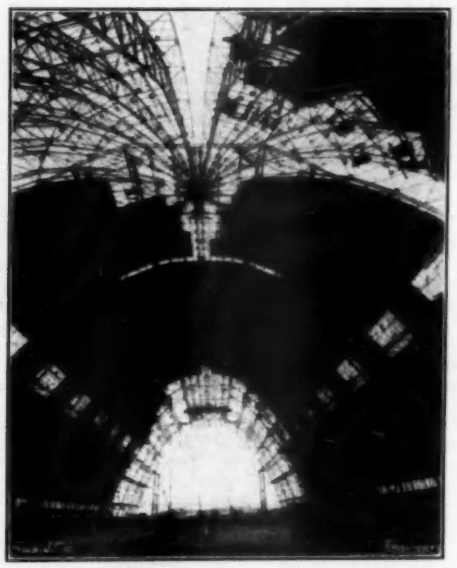
One of the unique features of the design is the entire absence of all expansion joints. The centre arches are fixed in position, and all others are carried on rollers, placed transversely to the axis of the structure, so as to allow it to expand freely as a whole, from the centre to each end. This plan allows the end arches, supporting the upper door pintles, or hinges, to move laterally about 4in. under the maximum range of temperature a motion which is taken up partly on the pins themselves and partly by being transmitted to the doors, and absorbed by the deformation of the door frames. In order to reduce the lateral motion of the upper pins under wind loads it was decided to convert the three hinged arches into two hinged arches by riveting up the lower chords after the erection of the steel.

The most interesting feature of the building is, doubtlessly, the spherical doors with their hinges and supporting trucks and the operating mechanism for opening and closing them. Neglecting any snow or wind on them, the doors alone weigh about 600 tons for each leaf, or 1200 tons for each end of the building. The doors are 202ft. high, and each leaf is 214ft. wide at the bottom. They are supported on forty forged steel double flange wheels, 27in. diameter, running on two 100 lb. rails set to standard gauge, and curved to 187·69ft. radius. The pressure on the wheels is equalised by means of heavy springs. The track is carried on a reinforced concrete base, 10ft. wide and deep enough to go below the frost line, and under this runway is a series of concrete piles driven down to the solid rock.

The hinge pins which fasten the top points of the doors to the main shell of the building are secured by heavy steel frames to the roof girders, and a separate pin for each leaf of each door is provided, the two pins at either end being spaced 4ft. apart. It is estimated that the pressure against the pin may reach a maximum of about 550,000 lb. inward, or 450,000 lb. outward, depending on the snow and wind load. To accommodate expansion movement, a horizontal thrust bearing in the form of a ball and socket joint, is provided and is designed to be free to move in any direction within moderate limits. The pin is 17in. in diameter and about 6ft. long, and the bearing ball is about 30in. in diameter. The bearing can move up and down on the pin through a range of 4in. each way to provide for change in the height of the door produced by expansion and contraction. The doors are electrically operated by means of special motors capable of being used at two speeds with a constant torque effort. The power system can be connected up to operate the doors at a maximum speed of 20ft. of travel per minute, or at 40ft., as desired.

The designers of the structure had contemplated erecting the steel frame by using a traveller which would be supported upon three standard-gauge railway tracks, one on the centre line of the building and one on each side, spaced 100ft. therefrom, and on the centre line of the proposed docking rails. This traveller was to have been designed to pass under the trusses with its derricks removed. The American Bridge Company, the contractors, deemed this method of erection to be too slow, and developed an alternative plan which was submitted to the designers and approved by them. This method consisted of erecting the lower sections of a pair of the arches about 100ft. in height and 80ft. apart upon temporary bents, placing all the bracing between the arch ribs to this height and then assembling the centre portions of the arches on the ground, upon a cradle, and lifting them into position by means of counterweights carried upon the side sections already erected. The hoisting was carried out by means of locomotive cranes equipped with drums.

The shell of the building is supported by eleven full arches and two sets of end diagonal arches. Only the



INTERIOR OF SHED DURING ERECTION

three centre arches have fixed shoes, the others, as already stated, being supported on rockers, allowing the structure to expand and contract from the centre to the ends. Erection started with the southerly two arches of the three fixed centre arches, and proceeded southward to the south doors. The doors were erected in the open position, supported upon the exterior of the main structure, and assembled by using locomotive cranes to as great a height as they could reach and then by utilising a derrick traveller placed on top of the arches. The scheme of erection involved the use of eight lines of railway track, two outside the building and six inside. Altogether, about one and a-half miles of standard-gauge track was used at one time, over which ran seven locomotive cranes, five with 50ft. booms and two with 105ft. booms and goose-necks which gave them a total reach of about 125ft.

The erection bents for supporting the side sections of the arches consisted of two steel columns, each supported upon a 300-ton jack at its base, the function of the jack being to spread the tops of the lower sections enough to allow the centre section to pass by and then to bring them together again in order to effect the closure between the two sections. At the top of these columns were placed sheaves for carrying the counterweight boxes weighing about 72 tons each when loaded and equivalent to about 80 per cent. of the weight of the centre portion of the span, leaving about 20 per cent. to be lifted by the cranes. Each centre section as erected weighed about 360 tons. The centre sections were assembled by the cranes upon cradles which consisted of longitudinal girders carrying the ends of the arches and transverse ties

to take the thrust. During the lifting of the centre section of an arch truss the four corners were kept level by means of weighted piano wires and graduated boards which served as height gauges or telltales. On page 48 we reproduce three photographs illustrating the erection of one of the arch sections.

The erection of the steel work was begun on April 29th, 1929, and the south end doors were completed by September 1st and moved into the closed position on September 16th. The north diagonals were completed by October 18th and the north doors were closed by November 25th. The protected metal sheeting followed the erection of the steel as rapidly as possible, and is now completed. It was expected that all work on the building and accessories would be completed within practically one year from the time the first pile was driven. The building includes 5500 tons of structural steel in the shell and shops, excluding the doors, in which material to the amount of about 1900 tons is used. The roof area is 693,000 square feet and there are 28,000 square feet of vertical sash lights and 23,000 square feet of skylight.

The work was carried out for the Goodyear Zeppelin Corporation under the supervision of Dr. Karl Arnstein, director of engineering, and Mr. W. C. State, consulting engineer. The architects and engineers were Wilbur Watson and Associates, and the contractors for the steel work for the main structure were the American Bridge Company, which has supplied us with the information given in this article, through Mr. H. R. White, United States Steel Products Company, London.

The Physical and Optical Societies' Exhibition.

No. I.

THE twentieth annual exhibition of the Physical and Optical Societies was opened at the Imperial College of Science and Technology on Tuesday, January 7th, and it closed on Thursday, January 9th. In the trade section there were over eighty exhibitors, whilst in the research and experimental section, covering exhibits illustrating recent physical research, lecture and instructional experiments in physics, and historical exhibits in physics, there were forty exhibitors. There was also a section for apprentices and learners, which was formed for the first time this year with the object of encouraging craftsmanship in the scientific instrument trade. Another feature was a series of lectures delivered on each of the three days the Exhibition remained open. The title of the first, which was delivered by the Right Hon. Lord Rayleigh, was "Iridescent Colours in Nature, from the Standpoint of Physical Optics." The second was on "Gyro-compasses for Gun-fire Control," and was delivered by Mr. S. G. Brown; whilst the third, delivered by Sir Ambrose Fleming, was on "Television: Present and Future."

The trade exhibits were quite up to the usual standard, and most of the firms that usually display

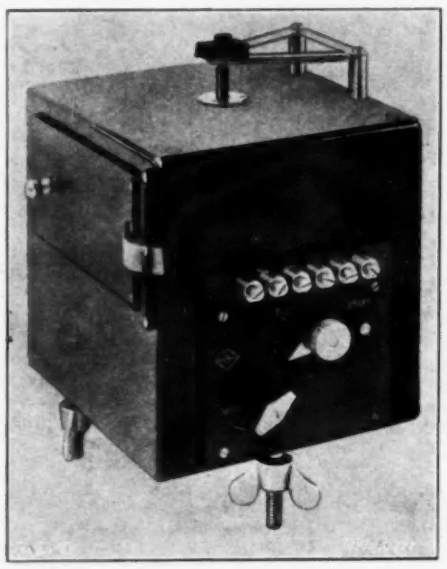


FIG. 1—UNIVERSAL DEFLECTOGRAPH—CAMBRIDGE

their goods at this Exhibition were in evidence. As usual, the Cambridge Instrument Company was showing a number of interesting instruments, including a universal deflectograph, a seismograph for geo-physical survey, a humidity recorder, a recording colorimeter, and a simple moving magnet galvanometer. The deflectograph illustrated in Figs. 1 and 2 is a portable instrument for recording the relative movement between any two parts of a machine or other structure. It can be used in any plane, and, being small and compact, can be applied to almost any part of the machine under test. The principal feature of the instrument lies in the method adopted for recording the movements, which does not depend upon optical or photographic methods, but is, nevertheless, capable of great accuracy, even when recording rapidly changing movements. The records are obtained by the action of a moving stylus upon transparent celluloid film. The pressure upon the stylus is extremely light, and the celluloid flows plastically under the rounded point of the stylus, the line produced having optical characteristics which render any point on the enlarged image of the diagram readable with a high degree of accuracy. The moving parts of the instrument are small, and are arranged to move through small distances, so that rapidly varying movements are recorded accurately and are undisturbed by instrumental inertia effects. The stylus-on-celluloid method of recording also offers the advantage of durability, for the record cannot fade, and is impervious to oil or water. Fig. 2 gives

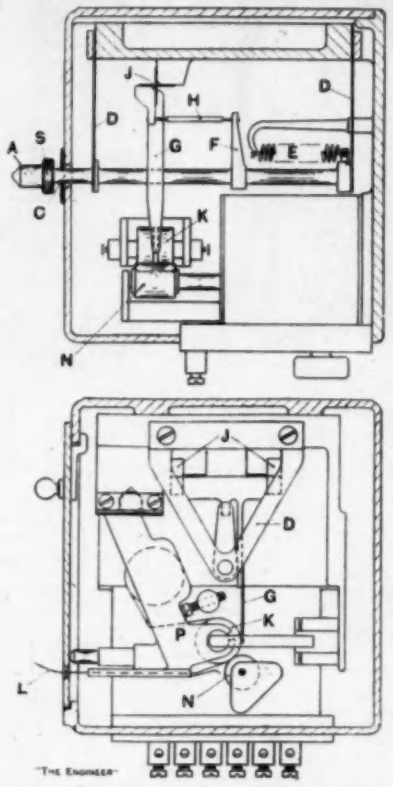


FIG. 2—ARRANGEMENT OF DEFLECTOGRAPH

diagrammatic views of the instrument. The deflectograph is clamped firmly to one part of the machine, so that the toe A is pushed against the part it is desired to test. By means of the knurled head S the toe is then locked so as to make it rigid with the bar C, which is carried on the flexible strips D D so that it is free to move in one plane only. The bar C, carrying the toe A, is held in position against the moving part under test by means of a light spring E. Attached to the bar is a stiff arm F, which operates the arm G, carrying the stylus, by means of the flexible coupling H. The stylus arm is pivoted from the case of the instrument by the spring hinge J, which gives a frictionless movement. Any relative movements between the two parts of the machine cause movements of the toe A and therefore of the bar C, and these movements are communicated to the stylus arm G, the length of the arm being such as to magnify the movement five times. The magnified movements are recorded by the stylus at the end of the arm G upon a strip of transparent celluloid film, which is moved over the drum K, by the driving drum N operated by means of clockwork mechanism. The rate of movement of the celluloid film can be varied from about 3 mm. to 20 mm. per second. After passing under the stylus, the film strip passes outside the instrument case through a guide. The film is kept in contact with the stylus by a spring plunger, and, if necessary, the pressure of the stylus on the film can be adjusted by means of the screw P. Two independent datum lines are also traced on the opposite surface of the celluloid strip by means of two separate styles controlled by electro-magnetic time and position-recording mechanisms. These styluses are enclosed within the drum K, and operate through a gap in the drum. The time-marking stylus is usually controlled from a contact-breaking clock, while the other stylus is connected to a contact on the machine, enabling the position of any particular movements of the machine to be automatically marked on the record. The clock-work mechanism driving the celluloid strip is set in motion and stopped either by hand on the instrument itself or by an electrical device controlled automatically, or by hand, from a distance.

The records obtained are of small dimensions and are permanent. The lines forming the records are clearly defined, and will bear considerable magnification, so that the movements can be measured to 0·01 mm., or 0·0004in. The records can be cut from the celluloid strip and examined immediately after they are made without chemical treatment or any lighting precautions. They are durable, and are claimed to be capable of withstanding the worst conditions of dirt and wet without special handling precautions. They can be examined by means of a microscope, or direct enlargements can be obtained by photographic methods, by a camera lucida, or by projection.

The Cambridge humidity recorder—shown in Fig. 3—was originally developed for determining the humidity of paper when on the rolls of the calendering machine, and it has the important advantage that

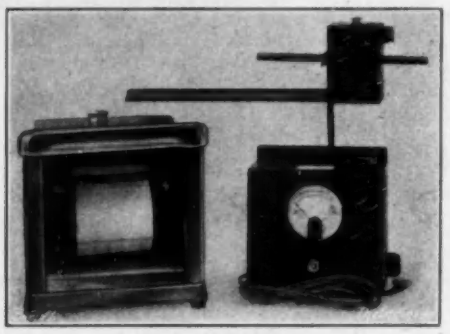


FIG. 3—HUMIDITY RECORDER—CAMBRIDGE

the humidity records are not affected by changes in temperature over a long range. The apparatus is therefore suitable for a wide variety of purposes. As it will work efficiently at temperatures below zero, it is particularly useful for recording variations in the humidity in freezing chambers, refrigerating rooms and cold stores. An interesting application is the recording of the humidity in the fan chamber of large organ pipes in cathedrals, churches, cinemas, and public halls. The operation of the recorder depends upon the fact that goldbeater's skin varies in length with the hygrometric state of the surrounding atmosphere, these variations being accurately repeatable if the skin is maintained under certain conditions of load. A strip of goldbeater's skin, held under tension, is exposed to the air in the position at which it is desired to measure the humidity. One end of the strip is rigidly fixed to the frame on which it is mounted, while the other end is connected to an electrical micrometer, by means of which the movements of the goldbeater's skin are electrically recorded. Fig. 4 shows

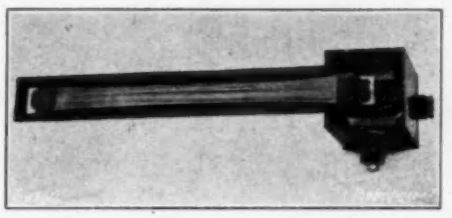
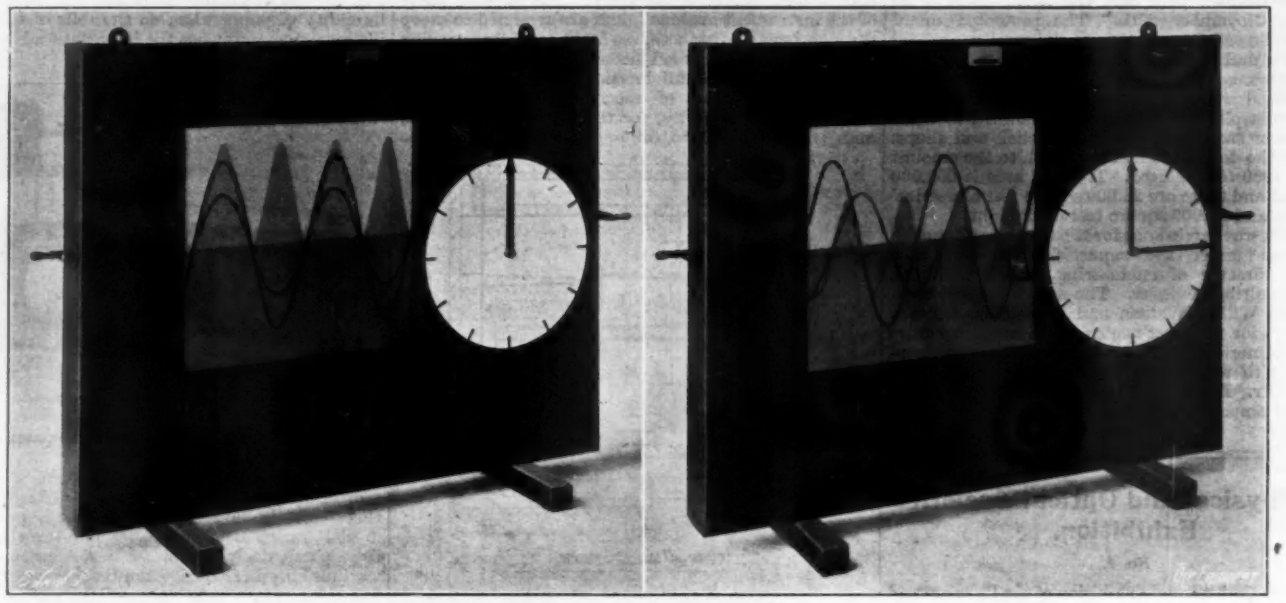


FIG. 4—GOLDBEATER'S SKIN IN FRAME

the goldbeater's skin in its frame, together with the micrometer mechanism, while Fig. 3 shows the complete equipment. The electrical micrometer, the design of which is due to Dr. G. A. Shakespear, of Birmingham University, comprises four identical spirals of platinum wire arranged to form the four arms of a Wheatstone bridge, through which a constant current is passed. When the length of the goldbeater's skin strip alters, owing to changes in the humidity, two of the spirals, forming one pair of arms in the Wheatstone bridge, are extended, and the other two, forming the opposite arms, are compressed. This extension and compression causes changes in the resistance of the respective coils, thereby throwing the Wheatstone bridge out of balance, and causing a deflection of the galvanometer pointer. The galvanometer forms the moving system of a "Model B" thread recorder, which is a simplified form of the well-known Cambridge thread recorder supplied for measurements of temperature, CO_2, &c. It is calibrated to read directly in terms of relative humidity, the usual range being 30/100 per cent. The recorder can be installed some distance away from the position at which the humidity measurements are being taken. Current for the Wheatstone bridge circuit is supplied from a dry cell or accumulator. The leads from the electrical micrometer, and from the battery, are connected to an ammeter box, and a milliammeter mounted on the front of this box indicates whether the current in the Wheatstone bridge is steady, and by adjusting a rheostat contained in the box, compensation is made for variations in the battery voltage.

Every lecturer on alternating current is aware of the importance of a clear and lucid explanation of the theory of power factor and of the difficulty of explaining it by diagrams. To overcome these difficulties Mr. H. E. Dance, of Liverpool, has devised the apparatus shown in Figs. 5 and 6, which was exhibited by the makers, G. Cussons, Ltd., of the Technical Works, Lower Broughton, Manchester.

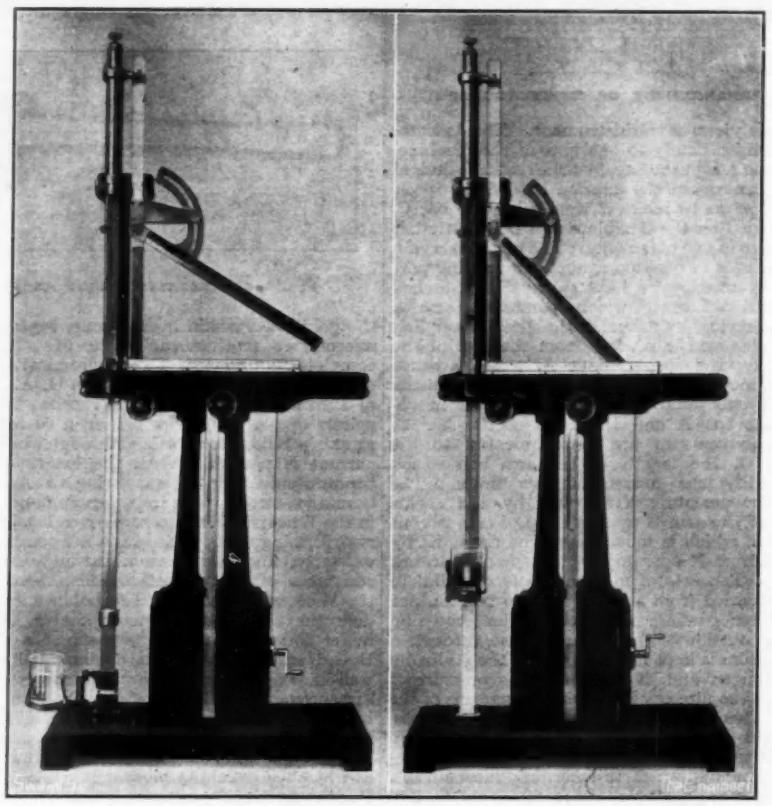
Though intended to be used chiefly for explaining the meaning of power factor, the apparatus may be used with equal advantage and facility to illustrate the nature of the force operating on a conductor in an alternating current field; in fact, the apparatus is applicable to any theory involving the product of sinusoidal quantities of equal frequency. Sinusoidal curves of voltage and current are drawn in black and red on transparent celluloid sheets, and areas contained between the power curve and the axis are shown in colours. Thus, the energy delivered by the system is represented by a blue area, and the energy withdrawn by a yellow area, and the magnitudes of these areas change automatically in accordance with the change of phase. Hence, the conditions under which power becomes negative may be experienced, and the attention of the student may be focussed on the diagram during the transition from



FIGS. 5 AND 6—APPARATUS FOR DEMONSTRATING POWER FACTOR

at the side these quantities are represented by vectors in corresponding colours. By turning handles the curves and vectors may be immediately brought into any desired phase relation. The handles are attached to a screwed cross shaft carrying a worm engaging with a worm wheel and cam linkage motion. The screws actuate the voltage and current curves by sliding them across one another, whilst the worm gear actuates the power curve, which is moved at right angles across the voltage and current curves and in the same plane. The movements occur simultaneously so as to give graphic indications of the variable values in sequence. As the range of the apparatus is through five right angles, it is possible to illustrate any phase relation. When, however, students are first introduced to the idea of power factor, it is convenient to illustrate the effect of phase angle within the range of 90 deg. leading and 90 deg. lagging, and, later, to demonstrate the reversal of power when the phase angle is greater. An important feature of the apparatus is that the one condition to another, a feature which is especially useful when dealing with the paralleling of alternators and similar subjects.

A gravitometer for light solids such as aluminium alloys, or other substances of specific gravities up to about 3·5, was shown by W. and T. Avery, Ltd., Soho Foundry, Birmingham. This device—illustrated in Figs. 7 and 8—is similar in principle to the gravitometer for determining the specific gravities



FIGS. 7 AND 8—GRAVITOMETER FOR LIGHT SOLIDS

of liquids which the firm showed at last year's Shipping and Machinery Exhibition at Olympia, and which we described in our issue of September 27th. The framework of the instrument carries a spiral spring to which is attached the body of which the specific gravity is required. By the vertical extension of this spring the weight of the body first in air and then in water is indicated. The rod depending from the spring and supporting the body carries near its upper end a light disc which serves as a gauge mark for measuring the extension of the spring.

With the body attached to the rod the right-hand knurled knob in Fig. 7 is turned to raise the horizontal graduated scale seen above it until the top edge of this scale is in line with the gauge disc on the rod. The distance of this horizontal scale below the level occupied by the gauge disc when the spring is free from load will now represent the weight of the body in air. This distance is indicated by AB in Fig. 9. A beaker containing water is then swung beneath the body and raised by means of the handle shown to the right of the instrument until, as depicted in Fig. 8, the body is immersed in the water. The disc, as a consequence, will rise to some such position as that shown at C—Fig. 9—the distance BC being proportional to the weight of water displaced by the body. The next step in the determination is to turn the left-hand knurled knob for the purpose of adjusting vertically a slide to which is pivoted a bar which may be clamped to the slide at any angle. The slide is adjusted until a mark on a projection from it directly in line horizontally with the pivot of the bar tallies with the gauge disc on the spring rod. The pivoting bar is then turned until, as shown in Fig. 2, its centre line registers with the mark "1" on the graduated

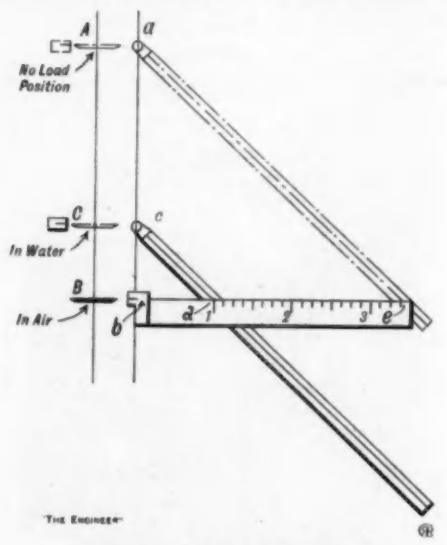


FIG. 9—SCALE OF GRAVITOMETER

horizontal scale. In this position the pivoting bar is clamped. The final adjustment consists of turning the left-hand knurled knob so as to raise the vertical slide carrying the pivoting bar until the pivot mark is in line with the zero position of the gauge disc, as indicated in Fig. 9 and as actually shown in Fig. 8. The attainment of this zero position is indicated by the vertical slide making contact with a stop.

From similar triangles $be : bd = ba : bc = BA : BC$ = (weight of body in air) : (weight of an equal volume of water) = specific gravity of the body. As bd is the unit of length adopted for the graduation of the horizontal scale it follows that the reading at e gives directly the specific gravity of the body.

It is claimed that a determination can be made in about a minute. It is also claimed that the design of the instrument is such that the readings of specific gravities made with it are independent of any temperature effect on the spring.

(To be continued.)

Railway and Road Matters.

BETWEEN May last and the middle of December one hundred new engines were built in the Crewe works of the London, Midland and Scottish Company.

THE 5.30 p.m. London and North-Eastern express from King's Cross to Newcastle was partly derailed when passing through New Barnet Station on Saturday, January 4th.

THE proposals of the London and North-Eastern to close the dock and wharves at Connah's Quay, contained in the Parliamentary notices, are meeting with considerable local opposition.

IT was recorded in this column on July 12th last that owing to the cost of living having fallen by five or more points, 1s. per week would be taken off the wages of those men—now only few in number—who still receive the war bonus. Now that the cost has gone up seven points, the shilling is being restored from January 1st.

THE retirement of Mr. A. B. Cane at the end of last year is announced. Mr. Cane was secretary of the Railway Companies' Association, and succeeded the late Mr. W. Temple Franks, on the latter being appointed Comptroller of Patents in 1909. Mr. G. Cole Deacon, assistant solicitor to the London, Midland and Scottish Railway, is the new secretary.

As showing the progress made by the railways since they obtained the necessary parliamentary powers towards co-operation with the road transport companies, it may be remarked that Mr. Ashton Davies, the general superintendent (passenger commercial), London, Midland and Scottish Railway, publicly stated recently that agreements have been made with interests owning 8000 road vehicles.

THE vacancy created by the death of Sir Christian Felling, in the position of general manager of the Kenya and Uganda Railways, has been filled by the promotion of Brigadier-General G. D. Rhodes, who has been the chief engineer and deputy general manager since 1926. General Rhodes was born in Canada and served in the Royal Engineers from 1907, and was Adjutant in the Railway Construction Corps, which left Longmoor in September, 1914, for France. Later he became Director of Railways in Salonika.

ACCORDING to a statement made by the Minister of Transport in response to a question by Sir William Edge, schemes for the elimination of the level crossings at the following have been sanctioned:—Bourne End (2), Irthlingborough, Lyndhurst-road, Weelsby-road, Felixstowe-road, Saffron-lane and Highley. Schemes are under consideration for their elimination at the following places:—Bamber Bridge, Hoghton, Wellingborough, Kingston-road (Merton Diversion), Allerton, Thorpe Willoughby, Rawcliffe, Hensell, Dodworth, Spofforth, Manor-road (Richmond).

FOLLOWING the note as to the first Tay Bridge which appeared in this column on December 26th, it may be noted with interest that "A. K. H. B." (the Rev. Andrew Kennedy Hutchinson Boyd) said in his "Twenty-five Years at St. Andrews" of the 4–4–0 locomotive concerned in the disaster: "The great engine was got up little the worse. It was put right and set running again. But, though railway boards are not much amenable to sentimental considerations, I am told it never has been sent across the magnificent new Tay Bridge into Dundee. I was shown it once in Glasgow."

IT has been decided to form a new committee of the R.A.C., to be known as the Highways Committee, and Sir Henry Maybury has agreed to act as Chairman. The Committee has been formed to take over and co-ordinate that part of the work of the R.A.C. which relates to road construction and the paraphernalia employed in connection with traffic regulation. The Committee will deal with such matters as automatic traffic signals, road signs, warning signs, white lines, road cambers, kerbs, road surfaces, by-passes, level crossings, dangerous corners, one-way streets, high hedges, ferries, toll bridges, parking places, and so forth. It will have power to carry out experiments and demonstrations, and will take opportunities as occasion arises to lay its views before Government Departments, police authorities, county and other councils, surveyors, &c.

SINCE Christmas Eve the Great Western main line near Dawlish Warren Station—on the Exeter side of Dawlish—has had its down main line closed to traffic owing to a crack in the sea wall on which the railway at this point runs. During a heavy south-westerly gale on Saturday night last a further breach was made, which was of such a serious character that both lines had to be shut down. Expresses to and from Plymouth and beyond use the Southern Railway between Exeter and Plymouth, North-road, their direction being reversed at each of those stations. Those for Newton Abbot and the Torquay line travel from Exeter, St. Thomas, over the Great Western Company's own Exeter Railway to Heathfield and thence over the Moretonhampstead branch and thereby join the main line again at Newton Abbot. The latter road would be very inconvenient for the Plymouth expresses, as it is single throughout and has severe gradients.

AFTER having had in 1927 and 1928 the two worst consecutive years in the number of passengers killed in train accidents since 1873–74, it is a matter not only of satisfaction, but of pride, that last year was one of the best in that respect. There was only one fatal accident, which is a record which has been only twice excelled—in the absolutely clean years of 1901 and 1908. The record, further, has been equalled only thrice—in 1909, 1917, and 1925, when also there was only one fatal accident. In the accident in question last year, two passengers lost their lives, and the only similarly satisfactory years, besides those of 1901 and 1908 when none were killed, were 1909 and 1925, when one passenger lost his life In no other year was the total as low as the two of last year. The fatal accident of last year was the collision at Ashchurch on January 8th, and we have delayed this, our usual, note for one week so that the anniversary of the accident would be passed and we would be able further to record that twelve months have now elapsed since the last fatal passenger train accident.

Notes and Memoranda.

A RECORD is claimed for the Canadian output of newsprint during November last, when 252,046 tons of paper were produced.

THE territory across which the Hu-hai Railway runs, is a high level plain, having on its north, west, and east the ranges of the Great Kingan Mountain. Being well irrigated by the tributaries of the Sungari River, it is considered the best region for agricultural purposes in all Manchuria.

IT is noteworthy that the *Far Eastern Review* says that the damage to the electric transmission lines of the South Manchuria Electricity Company, caused by the repairing gangs of the railway track, is such that it has been decided to expend some £30,000 on rearranging the line of the transmission system.

ACCORDING to the *Industrial Bulletin*, of Massachusetts, the Gulf Refining Company is producing 40 tons of anhydrous aluminium chloride a day, most of which is used in the McAfee process for converting high boiling petroleum oils into petrol. This process possesses many advantages over the cracking process, which depends on heat alone. Aluminium chloride has also been found to be a superior refining agent for petroleum oils in general, and for highly viscous lubricating oils in particular. Large quantities of aluminium chloride are used for refining purposes.

AN article in *The Times*, reviewing the progress of corrosion-resisting metals during the past year, mentions one extremely interesting adaptation of stainless steel to industrial purposes. The writer states that it is now being used for the identification discs which are shot into whales in order to track their movements in the Arctic seas, and that the "Discovery" is carrying hundreds of them with her to the Arctic. It appears that hitherto every form of metal plate used set up a septic action, which enabled the whale to shed the plate, but the stainless steel plate is unchanged by salt water, and the arrow attached to the disc, once embedded in the blubber, remains until the whale is caught.

WHAT is claimed to be the first laboratory for electrical testing at pressures up to two million volts has lately been completed at the transformer works of the Koch and Sterzel Gesellschaft, at Mickten, Dresden, Saxony. That the firm has for many years realised the importance of having adequate facilities for testing electrical equipment is indicated by the steady advance that has taken place. It is interesting to record that it had a laboratory equipped for tests up to 50 kVA capacity at pressures up to 500,000 V as long ago as 1918, which was followed in 1922 with one capable of permitting tests up to a million volts and 200 kVA, while now, the capacity has been increased to two million volts and 1200 kVA at 5 periods.

THE competition between alcohol and petrol will, according to Mr. L. Eynon, be governed by comparative efficiencies and prices; alcohol has a lower calorific value than petrol, but this is approximately compensated by its higher ratio of work done to heat expended. If the rather moderate estimate of 4 tons of sugar as the yield per acre under sugar cane is accepted, then, reckoning that this quantity of sugar yields 520 gallons of alcohol, 1 acre would suffice to support two small cars, each travelling about 7000 or 8000 miles per year. When it is taken into account that one light car, used to this extent, would consume about 2 tons of sugar per year, *i.e.*, as much sugar as is eaten by fifty people in this country, and that mechanical transport on land, on the sea and in the air will make an ever-increasing demand for fuel, Mr. Eynon does not think we need fear for the future of the world's sugar industry.

TUNGSTEN ore is mined in South China, in the provinces of Kiangsi, Kwangtung, and Honan, particularly in localities close to and along the border lines separating these three provinces. In Kiangsi, tungsten deposits are found in the southern part, in the districts of Lungnamshan, Tinam, Sinfenhsien, Nankanghsien, and Taiyu. At present this province produces most of the tungsten ore. In Kwangtung, deposits are found in both the northern and eastern parts of the province. In the northern part, the most important districts are Lokchong, Namyung, Chihung, and Chukiang, and in the eastern part Wuwha, Hungninghsien, Kaiyung, Heifung, Lukfung, and Wailia. In the province of Honan, deposits occur in the southern part at Hangchow and vicinity. The districts mentioned are only those in which chief mining operations have been carried on. There are, according to Mr. Tam Wah Ding, large tungsten deposits in many other areas of the three provinces, which have not as yet been opened or, rather, where the deposits are being mined in a very insignificant scale.

COAL dusts vary greatly in their degree of inflammability, but there has not existed hitherto a laboratory test of this inflammability capable of replacing satisfactorily the laborious and rather costly method of repeated trial in large-scale explosion galleries. The difficulties involved in producing a simple test were discussed in Safety in Mines Research Board Paper No. 31, published a year or two ago. Such a test has now been evolved, and is described in Paper No. 56, by A. L. Godbert and R. V. Wheeler, just published—H.M. Stationary Office, price 6d. net. The method of test is to measure the inflammability by ascertaining the proportion of inert dust necessary to suppress inflammation when small quantities are blown by oxygen through a heated tube. It has been proved to give results comparable with the explosion gallery trials. A refinement of the same test was used to study the effect of the fineness and chemical composition of coal dust on its inflammability. Safety in Mines Research Board Papers 33 and 48 had shown that the inflammability of a coal dust ran roughly with its volatile matter content, but there were notable exceptions to the general rule. The present paper proves that there is a much closer relationship between the inflammability of a coal dust and the reactivity of its ulmin compounds, as demonstrated by their relative capacity for absorbing oxygen. Occluded gases were found not to affect materially the inflammability of the dusts.

Miscellanea.

A NEW shaft, at least 4000ft. deep, is to be sunk on the Frood property of the International Nickel Company of Canada.

THERE is a scheme in view for a system of wireless communication between Tientsin, China, Canton and Sinkiang.

THE concrete sleeper depôt of the Canton–Kowloon Railway is making reinforced sleepers at the rate of about 5000 pieces a year.

IT is said that the abolition of night-shift work in the cotton mills of Japan has been accomplished without any serious disturbance of the industry.

IT is proposed to build a hydro-electric power plant of 40,000 kilowatts in the Shizomaka Province of Japan. The principal units will be of 8000 kW each.

THE manganese ore handling plant which is to be put up at Congella, Durban, by the Wellman Smith Owen Company, is to have a capacity of 2000 tons per eight hours shift.

DURING the past three months the R.A.C. has installed twenty new road telephone boxes in various parts of the country. The R.A.C. now has 420 of these boxes, all of which are available for the use of members at any time of the day or night.

THE Whitworth Society made a donation of £25 to the College of Technology, Manchester, last July to provide prizes for the encouragement of promising students preparing for the Whitworth Scholarship examinations. The first awards have now been made to F. F. Butterworth, 54, John-street, Rochdale, and F. C. Thornley, "Arnside," Stockport-road, Hyde. The Society hopes to make similar donations to other colleges as funds may permit.

PLANS for manufacturing sulphate of ammonia by the South Manchuria Railway Company, Ltd., are progressing steadily. According to the report, 100,000 tons of raw material will be obtained from Anshung Ironworks and 200,000 tons from the Showa Seiko K.K., and total production is expected to be about 300,000 tons, an increase of 292,000 tons over the present production of 8000 tons, of which 5000 tons from Chufun and 3000 tons from Anshung. The company will use the Ude method.

ACCORDING to reports from the cable steamers now attempting to repair the submarine telegraph cable breaks caused by the earthquake off the North American East Atlantic coast, the ocean bed has been radically changed over the affected area and will need to be re-charted. Soundings taken over an area of 200 miles' length when approaching Cape Race showed variations as great as 40 to 50 fathoms from the soundings recorded on existing charts. Only a few of the chart soundings were found to be correct.

THE British Empire Steel Corporation is making good headway with its programme for the substitution of electricity of steam in the operation of its coal mines. Its power plant on the southern side of Sydney Harbour has now been linked up with its Sydney steel plant, and a high-voltage line is being run in a submarine cable under and across the entrance to Sydney Harbour to connect the workings at Sydney mines with the power plant. At number IB Colliery a large compressor, said to be the most modern of its kind, is to be installed.

THE Birmingham Corporation, which owns the largest municipally controlled fleet of omnibuses in the world, will purchase the whole of its petrol requirements for 1930, amounting to 3,020,000 gallons, from Russian Oil Products, Ltd. (R.O.P.). This is the first time in many years that the Birmingham Corporation has given the whole of its contract to one firm. Other Midland Corporations purchasing Russian oils include Burslem and Crewe. Soviet oil imports into Great Britain grew from 123,000,000 gallons in 1928 to well over 200,000,000 gallons in 1929.

AFTER negotiations lasting several years a provisional contract for the exploitation of the Narva waterfalls was signed at Reval on December 22nd between the Esthonian Ministry of Trade and an English company, the International Hydro-electric Syndicate. The syndicate is to receive a concession for the establishment of a 50,000-kW power station, the cost of erection being estimated at 30,000,000 kroner. During the negotiations the syndicate has been competing with a German banking company and another bank in San Francisco, and with the Siemens-Schuckert Company.

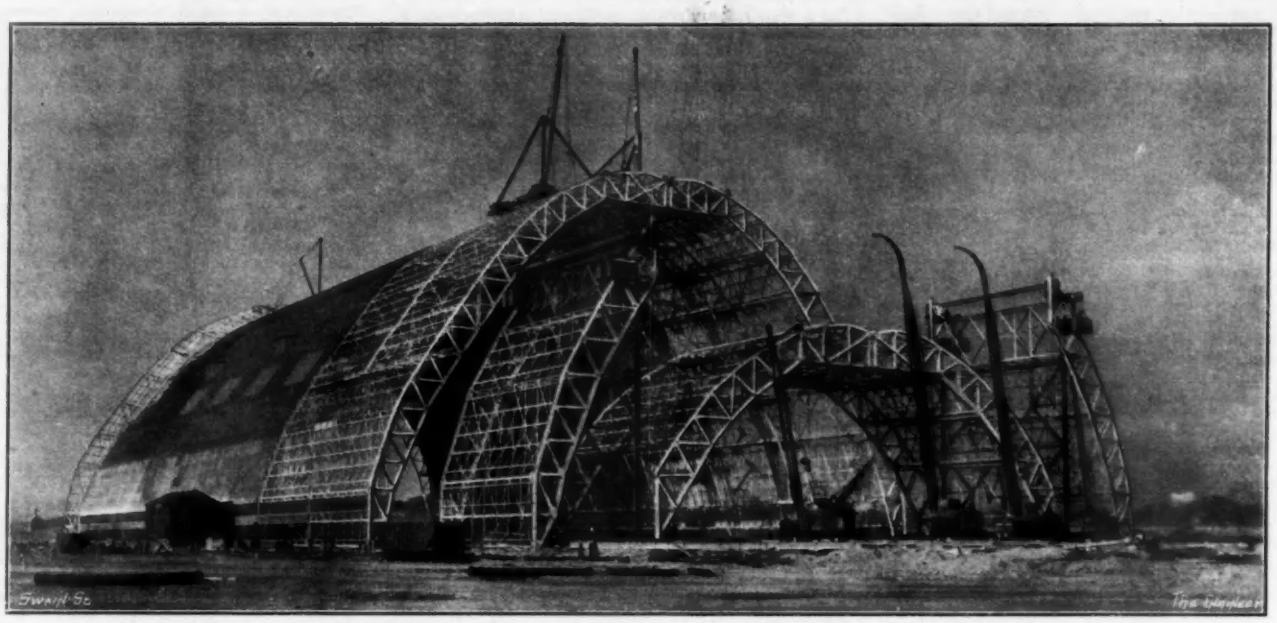
A SCHEME to use a secret submarine cable laid across the English Channel during the war to provide telephone service between the Channel Islands and the mainland has been placed before the British authorities by the Guernsey State Telephone Authority. The cable, it is stated, was laid between Dartmouth and France, and passed close to the western coast of Guernsey. Sir Chas. Kitts, a member of the Guernsey Telephone Council, has seen responsible people in London with regard to the project, and they have seen the advantage of a cheap telephone service for British buyers of the fruit, vegetables, and flowers which are exported from the Islands. By taking advantage of the secret war cable, it was anticipated that a telephone service could be quickly established to serve both Jersey and Guernsey.

THE production of two new types of steel is announced, one from France and one from Germany. The French steel, which has been named Durapso, has the following properties:—Tensile strength, 50 kilos. to 60 kilos per square millimetre (31·75 to 38·10 tons per square inch); elastic limit, 34 kilos. to 40 kilos. per square millimetre (21·60 to 25·40 tons per square inch); elongation, 24 to 30 per cent. It will bend until the two halves of the test piece become parallel at a distance of the thickness of the test piece. It greatly resists corrosion. The German steel, which has been used in the construction of the boilers of the "Bremen," is known as Izett. For it, it is claimed that it does not become brittle when cold worked, and that it prevents the formation of cracks, especially in rivet holes and at rivet heads. It is a carefully made open-hearth steel which has been treated with manganese during the melting stage, then deoxidised with aluminium, so that the final product contains 0·02 per cent. of that metal.

GOODYEAR ZEPPELIN AIRSHIP SHED AT AKRON, OHIO

THE AMERICAN BRIDGE COMPANY, CONTRACTORS

(*For description see page 44*).



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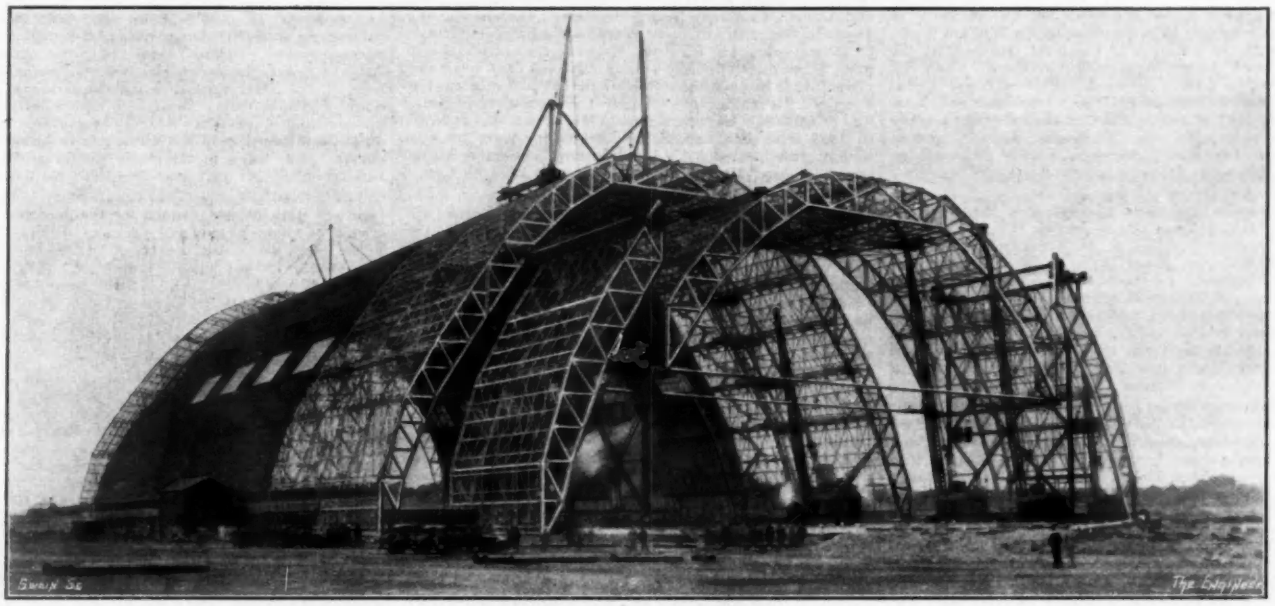

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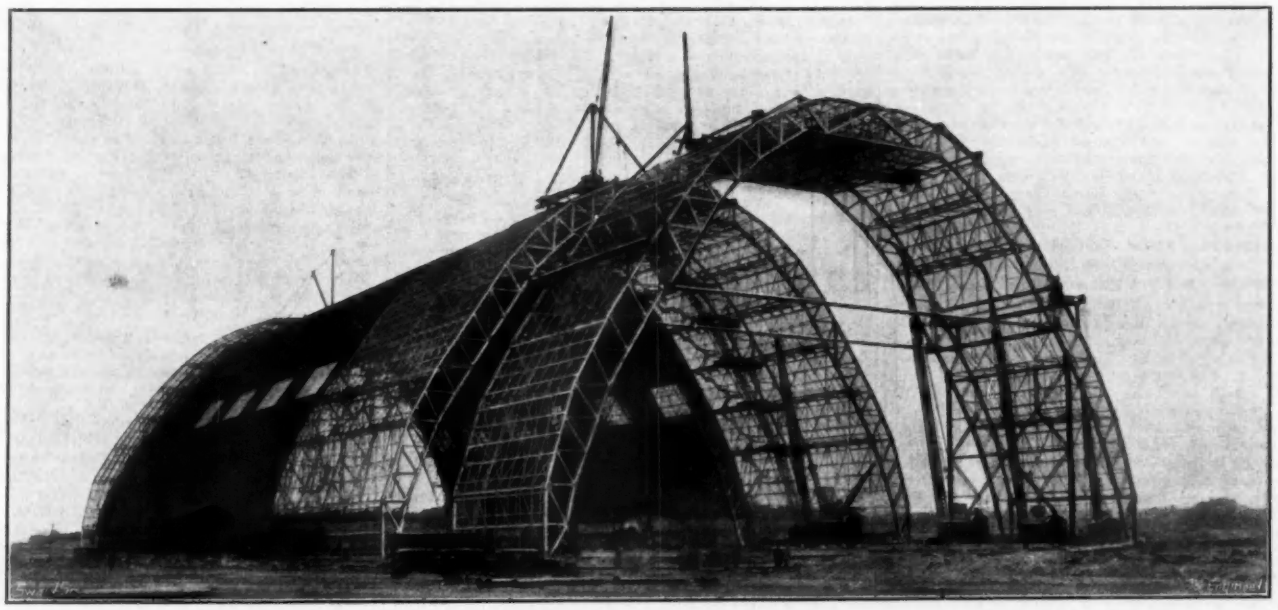

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THE ENGINEER.

JANUARY 10, 1930.

A Century of Naval Engineering.

THE decision recently reached by the Engineer-in-Chief of the Fleet, Engineer Vice-Admiral R. W. Skelton, and his Department, to place on record in the third Thomas Lowe Gray Lecture an account of the progress made in naval engineering during the last century is to be welcomed by all engineers. An abstract of Admiral Skelton's lecture, which was delivered on Friday last before the Institution of Mechanical Engineers, is given elsewhere in our present issue. Those who attended listened with evident appreciation to a review of marine engineering progress, which was valuable, both on account of its human and technical interest. Many engineers, we believe, will look forward to reading the full lecture, which is to be published in the "Proceedings" of the Institution. In the comparatively short time at Admiral Skelton's disposal, he touched upon the long series of changes, in the gradual evolution of new and improved types of propelling and auxiliary machinery put into service since 1829, when the first steam fighting ship, H.M.S. "Dee," was laid down at Woolwich. The earlier events which are less widely known than those of more recent date were dwelt upon by the lecturer in some detail. It was thus possible to follow the steps in the development of successive engine types from the beam and side lever engine to the modern geared steam turbine unit of high power or the development from the flue tube and cylindrical boiler to the oil-fired, high-duty, water-tube boiler of present-day design. The outstanding feature of the review is the interplay of naval and mercantile practice, and the constant help of marine engine designers and allied industries in the solution of naval problems. On the other side, the careful observation of engineer officers and the experience gained in service often prepared the way for a further step in advance.

In the earlier years marine engineering advances were held back by the desire to retain the sailing qualities of ships and the need for lifting the propeller. With the introduction of the iron ship and the provision of more accommodation below the water line, higher engine speeds and new designs were adopted, and later it was possible to make use in the Navy of Kirk's excellent work on triple-expansion engines. Boiler troubles seem to have been experienced at recurring intervals, but they, and the difficulties with the surface condenser, were surmounted when the necessity of a clean feed free from air was fully appreciated, and when suitable metals for tubes and shells became available. It is interesting to read that the commercial production of seamless tubes was brought about by a boom in bicycles, but this is only one of many instances of the many-sided needs of naval engineering. The Admiralty committees on boiler pressures seemed to have no doubt of the economies which would be brought about by the use of higher pressures, but the danger of too quick a movement in this direction in pre-war years was illustrated by the troublous experience with the Belleville boiler, which having given good results in the French mercantile marine, caused a good deal of anxiety to naval engineers. It is a great credit to the engineering *personnel* that difficulties in operation were surmounted and satisfactory operation was later achieved. Admiral Skelton's statement that the successful outcome of the late war—which turned ultimately on the endurance of the British Navy—was in a great measure due to the perfection of the engineering machinery of the Fleet, which was developed and operated by the *personnel*, who were intensively trained and tried, both in design and operation, in the troubled times of the Belleville boiler, is a striking instance of the possible value to engineers of difficult experience, if it be met in the right way. In the introduction of the steam turbine, the geared turbine, and oil fuel, progress was unretarded, and the Navy kept step with the mercantile marine. When some years ago difficulties were encountered with double-reduction gearing in mercantile ships, the good experience of the Navy with single-reduction gearing was often referred to. It is a tribute to both workmanship and materials that out of some 720 sets of gear fitted in naval ships, transmitting powers ranging up to 36,000 I.H.P., only five cases of failure on service, which entailed renewal, are on record. With regard to the oil engine, it appears that the lack of a suitable heavy-oil engine held back the application of that type of prime mover to submarine work for some years. The extensive research and development work which was done by Vickers Ltd. on the airless injection engine led to the utilisation of that type of engine in practically all submarines. The steam-propelled "K" class submarine formed, however, an interesting departure from that practice. With the founding of the Admiralty Engineering Laboratory in 1917 the oil engine problem was attacked under the leadership of Engineer-Commander C. J. Hawkes, and twin-screw 3000 S.H.P. oil engines based on the designs of the Laboratory are now installed in the submarine "X 1." Their weight is apparently 51 lb. per horse-power. Admiral Skelton assesses the difference in economy between modern steam plant and oil engine propelling machinery at about 30 per cent., and while anxious to obtain that advantage, he is apprehensive of loss of reliability and increase of engine weight. In this respect the new German naval ships with oil engines for main propulsion and for cruising have aroused keen interest among marine engineers. The installation of geared twin-screw M.A.N. engines of 50,000 S.H.P. in the "Ersatz Preussen" and the use of a centre shaft cruising oil engine of 12,000 S.H.P. on the "Leipzig" promise important developments, especially as the engine weights have, by the use of alloy steels and special light metals, been reduced to something like 17·5 lb. per B.H.P. In referring to the contributions of the metallurgical industries to the advance of naval engineering, we cannot overlook the recent introduction of high elastic limit steels of the "D" quality and the "Martinel" steel which is now being employed in Holt Line ships. In his paper on the battleships "Nelson" and "Rodney," read before the Institution of Naval Architects in March last, Sir William Berry dealt with the great saving in weight made possible by the use of such new steels. Equally important has been the saving in weight introduced by the use of aluminium and other light alloys for internal fittings. In this respect the recent experience gained with stainless steel and light alloys in the construction of airships will prove most valuable to naval constructors and engineers. On the steam side, tribute must be paid to the work of Dr. Bengough and the Condenser Tube Corrosion Committee of the Institute of Metals, which has led to the more careful manufacture of condenser tubes and the increased use of cupro-nickel and monel metal tubes, which bid fair to banish trouble from this source. From the tables given by

Admiral Skelton we note that the best fuel consumptions are those of the battleship "Nelson," 0·789 lb. per H.P. hour, and the "Berwick," 0·89 lb. per H.P. hour. At the present time high-pressure Parsons turbines are to be installed in a new Thornycroft-built destroyer, and there seems no doubt that in the new ships an effort to reach Mr. Johnson's figure of 0·60 for the new "Empress" class ships will be made. Another promising factor for the reduction of weight is the increased use of welded instead of riveted structures, both for hulls and machinery scantlings, and great success has been achieved in these directions in recent continental warships.

In concluding his lecture Admiral Skelton pointed to the re-action between commercial marine engine designs and naval engineering progress. The necessity to design high-powered and highly economical propelling and auxiliary machinery has always acted as an incentive to intensive design in many branches of engineering and applied science. The forthcoming International Conference on Naval Disarmament may alter classes and types of ships, but we do not think that the demands made upon the naval engineer will be lessened; indeed, they will almost certainly be increased by the new problems which are likely to be presented. At such a time, a review of a century's progress, such as was given in the Thomas Lowe Gray Lecture, spurs us on to meet future problems in that high spirit which was characteristic of the pioneer workers in this most important branch of engineering science.

The Iron and Steel Institute.

IN our issue of last week we published a short letter from the Secretary of the Iron and Steel Institute, to which we desire to direct the attention of all whose interests lie with the great industries represented by that influential body. It is, we fear, an open secret that the Iron and Steel Institute has not been as well supported in recent years as it was at one time. The main cause is, no doubt, to be found in the depression from which the industry has been suffering. In such circumstances interest flags, youth seeks more promising fields for its endeavours, and older men are so concerned with business difficulties and worries that they cannot spare the time, and have little inclination, to pursue the technical side of their vocations. But whilst these may be the explanations of waning interest in the Institute, we say positively that they are not valid excuses for failing to support it. One has only to look through the long line that the "Proceedings" occupy upon the bookshelves, to dip into the contents, and to note the names of the eminent iron and steel masters, scientists and users who have contributed papers or taken part in discussions, to appreciate the enormous value of the work the Institute has done in the past and is still doing. Or, those who have known it for many years may throw their minds back to its autumn meetings and recall the receptions with which it has been honoured by foreign lands, to feel that it is respected and honoured in all parts of the globe, and that the influence of its labours and its importance to the great industries for which it stands are recognised wherever the advance of technology is encouraged.

The functions of technical institutions are, perhaps, not always completely understood. It is no uncommon thing to hear a potential member say that he does not join because he is unable to see what he "can get out of it." Very rarely does one hear anyone saying that he wishes to become a member because he believes that he can put something into it. Yet that ought to be the prime consideration. The man who pays his three or four guineas subscription a year from a selfish motive has no right to claim more than he pays, and it must be a poor mind indeed that cannot get that small return from membership. But the member who joins with the larger view, that by helping the Institution he helps the industry, stands not only to benefit himself, but to benefit all who are engaged in the same work. All the great institutions are composed principally of corporate members; that is, members who form one body for the common good, and there would be no sound reason for their existence if they ceased to confer mutual benefits—direct and indirect—upon all the members, and further the progress of technology. The small subscription must, therefore, be looked upon as a contribution to a common pool from which every one may draw in proportion to his own capacity. But whilst every great institution must look upon the mutual education of its members as its prime function, its duties and influence do not end there. In a score of ways, which the members do not always appreciate, it works for the general good of the industry it represents, and by its mere existence, if it is properly supported by the most representative men, it enhances the prestige of that industry. Just as invisible imports must be considered when estimating the economic power of a nation, so must these invisible services be accredited to the institutions which perform them. Amongst them we may include international relationships. The spread of knowledge would be far more difficult were it not for the work done by our great institutions through contact with their counterparts in other lands. Indeed, if such bodies did not exist it would be necessary to create them *ad hoc* for the reception of foreign delegates, or for the acceptance of invitations from the technologists of other countries to mix with them and see their undertakings.

It must be admitted that there are too many technical institutions in this country—those associated with engineering alone number almost one hundred—and we may continue to hope for the day when many of them will be amalgamated into a single body. But until that is done it is no less than prudence to support the leading representative society of each industry. In all that appertains to the technology of iron and steel the position of the Iron and Steel Institute is unassailable. There is no similar national body. It has a fine record of good work done well, and it has the potentiality of doing similar work. But it must, of course, be encouraged and supported by all those who are eligible for membership. It is impossible for such an institution to attain its highest influence without adequate means; but adequate means alone will not suffice. It requires more. It needs the continual sympathy of members, their unabated interest in the duties that it performs, their desire to expand knowledge by freely giving and receiving from their mutual experience, and their determination to make it always a really representative and influential organisation. The services such an institute can perform for its country are cumulative. The greater it grows in power and influence the greater grows its value and its ability to serve. We trust that Mr. Lloyd's letter will be carefully considered by all whose qualifications fit them to become members of the Iron and Steel Institute, and that before they decide hastily that it would not be worth their while to join they will remember that a representative technological and scientific body is a necessity of the industry and that the greater they can make that body the more useful it will become to them as individuals and to the progress and development of the iron and steel industry as a whole.

The World Engineering Congress in Japan.

(By Our Special Representative.)

No. VI.*

TOKIO, December 4th.

Among the many papers connected with railways are two that should not be overlooked—"Railway Transportation of Perishable Freight," by C. A. Richardson and E. T. McCormick, and "Collecting Snow Plough," by K. Hashima, Chief of the Mechanical Section of the Sapporo Division, Imperial Government Railways.

The former paper describes in detail the extensive use made to-day in the United States of the refrigerator car in the delivery from far-distant places of fruits and vegetables, the metropolitan areas all over the country receiving "fresh" garden produce from regions one, two and three thousand miles away. A triumph of mind over matter. The system had its start as long ago as 1869, since when the engineer has found a new occupation in which to specialise, and the refrigerator car of to-day is his creation. Through his efforts, also, the people on the China Coast are eating ice cream, cone and all, made in Seattle, and sent across the broad Pacific with the regularity of the mail. And this reminds us that at every main railway station in Japan to-day, the traveller may regale himself with ice-cream cones, sold at a price yielding enormous profit, which is one interesting minor result of the development of the refrigerating art.

In its modern ways, Japan is the most open-minded and least conservative of all countries, and England out here, has the reputation of being the most conservative. Years ago, an American engineer confided to the writer that in Tokio you could "sell anything once." He was speaking particularly of machinery. It was the era of the disappearing steam roller, when the city seemed to be buying every sort of machine on the market, and great crowds watched operations in the streets of a roadmaking and road-breaking character. Buildings were going up, the like of which were never seen before, and the view was expressed that the leisurely Japanese workman, accustomed to take his pipe and sip of tea at all hours as suited his convenience, would never submit to the discipline enforced in the new skyscraper building, and that his nerves could not stand the racket of the riveters. But times have changed, and the workman of to-day, like his brother in less restful lands, will be observed a hundred feet above the pavement hammering away at a piece of iron, or laying cement foundations in the bowels of the earth. It is all a matter of practice. He and his leaders are doing work that could not be done by them a decade ago, and everywhere they are seeking to improve upon their foreign teachers, applying ideas, weird enough, in architecture, for example, but still, their own ideas. All over the city, the results of the new thought are observable; let us remember, it is new thought among a people who for a thousand years had not been encouraged to think. A model for everything in life and after life, was before them, for them to follow; great penalties were imposed upon the adventurers, in thought or deed. The whole power of the State was directed to suppressing independent thought, and until quite recent times it was death to leave the land of the gods.

In these circumstances the modern renaissance strikes the beholder, and he asks himself what will be the outcome?

What motive it was prompted so extravagant an investment in costly machinery during the boom years—1917–21—much of it of little use under the conditions prevailing, need not be entered into, beyond admitting that the officials, traditional leaders of the people, were equally victims as were the masses of a universal epidemic of extravagance and waste, the consequence of easily acquired wealth. The emblems of vanity, however, have now been put away, and he to-day who will investigate will find a condition of affairs the very opposite of those existing a decade ago. Such a condition is suggested in a paper prepared by Mr. Hashima. North of Tokio, as winter approaches, the railways must deal with their most merciless enemy, the snow, and in the Hokkaido, the weather is as hard as in the same latitude on the Continent. Snow is the engineer's natural enemy in the northern island, and it prevails for six months of the year. To keep traffic moving is the great problem, and Mr. Hashima gives an account, in places dramatic, of his job, and how he fights the elements.

The winter temperature in the interior of the Hokkaido is much more severe than in the coastal districts, averaging 30 deg. Cent. Snow begins to fall in October and does not melt until April, the climate being greatly different from that of the main island, which stretches south and south-west through many degrees of latitude to the sub-tropical zone.

For years the railways have experimented with different snow ploughs, but they have never been able to dispense with manual labour, and the man with the shovel is still the prime mover. The ploughs used are Pilot, Russell, Rotary and the Jordan Spreader, and none gives complete satisfaction. Mr. Hashima, from his experience in the North, hit upon what appeared to his superiors as the rather paradoxical idea of collecting snow in the track and then dispersing it by means of a rotary. What was thought of this scheme may be told in his own words:

> "Nobody would listen to such an unusual idea at that time, because the general opinion was that it would be far better to clear the track with manual labour, although it might be uneconomical, than to employ this new method, which might possibly block the track should the Rotary snow plough get out of order."

Probably the engineer would not have been permitted to put his collecting snow plough at work had he not visited Canada, and received every encouragement from the experience of a fellow-engineer confronted with a similar problem—Mr. K. D. McLay, of the Canadian National Railways—who encouraged him to go ahead. And ahead he went, and the picture he draws of eternal work under a leaden sky, of the damage to trees, telegraph poles, the roofs of houses, by flying blocks of snow frozen hard as rock, and whirled into the air by the ploughs was never intended to be dramatic, but it is. At whatever cost, the line must be kept clear. In another day, the countryside would be snowbound, and contented enough in this condition, the people having laid in their winter supplies; but to-day the elements must be subdued to the necessities of man.

Before Japan had become thoroughly sophisticated in the commercial ways of the West, the foreign merchants of Nagasaki made fortunes exporting the pure, soft gold tokens of the Empire to the international market at Shanghai, a proceeding in "legitimate" trading upon ignorance that was to bear fruit in illwill in later years. The thought occurs in connection with two papers on the subject of the "Mint," notably a sketch of the history of the national coinage (Dr. T. Hirose). Coins were minted in Japan in very ancient times, when bronze cash were in circulation. The old currency, with its incredibly small denominations, a rin being the tenth of a farthing and shopkeepers' calculations descending

*No. V. appeared January 3rd.

to a thirtieth of one rin (one kotsu), came to an end in the 'sixties, when the first modern mint was established, in 1868, in Osaka, organised by British subjects, and equipped with machinery supplied from Hong Kong. In addition to producing the coinage of the realm, the Imperial Mint to-day turns out large quantities of medals and dies to the order of the public.

A paper on the "Rapid Transit Subways of New York City," by Robert Ridgway, must have more than ordinary importance for readers in Japan by reason of two facts. First, a subway identical to that in New York is now under construction in Tokio, the first of its kind in the Empire, and the city authorities have more than once been alarmed by subsidences under the street, traffic suddenly disappearing and great commotion ensuing. Four times these unpleasant incidents have occurred, and the subway company has been duly warned. The line is opened for about a mile from the pleasure quarter at Asaksusa to Uyeno Station, itself being rebuilt and much enlarged, and is now following the main street through the city from north-east to south-west, which continues for about 8 miles. It is not recorded that Mr. Ridgway visited this construction work, but probably he did. However, he has just visited something more important in Japan's communications system—the site of the proposed tunnel under Shimonoseki Straits, which will enable the traveller to go by rail direct from Tokio to Nagasaki—868 miles. According to newspaper reports—December 3rd—Mr. Ridgway was invited by the Railway Department to inspect the site and give an opinion on the form the tunnel should take. The official plan is to bore a tunnel, of a total length of 1600 m., but after a survey of the situation, accompanied by engineers of the Railway Department, Mr. Ridgway expressed an opinion decidedly in favour of the sunken tube, which would mean a considerable financial saving. The official estimates of cost by the subterranean bore project were some 34 million yen—and it is notorious that official estimates are invariably far below actual costs—while by the sunken tube plan, it was estimated, the scheme would cost some 14 millions less.

"The Camphor Industry of Formosa" (Kinzo Kafuku) reveals the present state of a Government monopoly which enjoyed high prosperity until the appearance in Europe of a synthetic product and post-bellum conditions caused a great falling off in prices. Formerly, the export trade in this unique industry was the monopoly of a British firm, which had a concession from the Japanese Government, but it was made an Imperial monopoly some quarter-century ago, when the tobacco and salt monopolies were created and the railways nationalised. At the present time, efforts are being directed towards lowering the cost of production of camphor and developing by-products.

That Japan, in the Middle Ages, apart from her China trade, which is probably at least fifteen hundred years old, had commerce with distant overseas countries, is clear from the records of such buccaneers who have become national characters, as Yamada Nagamasa, a gentleman who, in the thirteenth century found himself in Siam, stayed there, became adviser to the King, and married a Siamese princess. That there was still earlier communication with lands still more distant appears likely from a paper on "Damascene Steel" by Col. N. T. Belaiew, who refers to a sword now in the Victoria and Albert Museum, of Japanese craftsmanship, as being probably made of steel imported from Ceylon, which was the source of Damascene steel. This weapon is the work of Masamune, one of the greatest swordsmiths, who flourished in the eleventh century, and was one of an illustrious line of craftsmen whose works are the admiration of all beholders to-day. What a mighty fall between the Japanese craftsman of old and the modern producer of goods for the export market who has brought so much of disgrace upon his country's good name!

To present a guest with an old sword is about the highest compliment the Japanese can pay the foreign visitor. Even persons not interested in the enduring quality of these masterpieces of craftsmanship must, nevertheless, notice their superiority when placed alongside the swords of Europe produced in the Middle Ages. Perhaps there is still on exhibition in the Tower of London the sword presented to Lord Kitchener when he came to Japan as a member of the first Garter Mission—a wonderful blade, in a plain white-wood sheath, its haft embedded in a similarly plain handle. It looked, when the writer saw it in 1925, as if it were made yesterday, while other swords of great age were discoloured and their edges hacked and broken—looking their age. Little wonder the Japanese venerate the sword, but the old art has gone, like many another. In Japan's recent wars, many officers have gone into battle with swords forged hundreds of years ago, and like the knight of old have felt themselves immune from danger.

Credit for the longest paper of the 800 odd submitted to the Conference will probably go to the 35,000-word contribution from New York of Mr. F. L. Estep, member of a firm of consulting engineers in that city. It deals very thoroughly with the steel industry of the States and the machinery and methods used to secure the best results. Japan and China vie with each other in the production of the shortest paper, each in the neighbourhood of 500 words.

"Public Health Engineering: A Review of its Scope, Present Status and Trend," is the title of a comprehensive paper on conditions in the United States by three authors, George W. Fuller, Harrison P. Eddy and Earle B. Phelps. The chief impression received on reading this paper, even in abstract form, is that the engineer is a factor in most phases of our modern life, and that soon we will be further protected by medical engineers and astronomical and milk engineers. Twenty years ago, the great public thought of engineers mainly in connection with railways and bridge building, but we have, apparently, gone far from those simple days.

Though somewhat out of place, the paper on "Earthquake and Building Construction," by Dr. K. Mashima, Director of the Bureau of Civil Engineering, Department of the Navy, Tokio, deserves special notice. The theory of construction in an earthquake country such as Japan is treated mathematically. The feature of Dr. Mashima's contribution is his condemnation of reinforced concrete structures and endorsement of the steel frame "as the only reliable mode of building construction against great earthquakes." This authority considers there is nothing equal to steel-frame construction, "supported as it is by both theory and experience."

"Progress of Illuminating Engineering in Japan" (S. Seki) deals with a subject of fascinating interest to the Japanese people, however much or little they may care about the technical aspects of the electric light now seen in divers colours and designs. During the recent Edison celebrations, pictures of Edison, Swan, and a Japanese gentleman prominently associated with the introduction of the electric light into Japan, were placed in an illuminated tower in Hibiya Park, and with the surrounding illuminations made an attractive display. It might be noted here that the American, British and Japanese flags were displayed throughout the length of one of the main thoroughfares, so that if some people are inclined to attribute to the American all credit for the electric light, others are not so thoughtless. Japanese illumination peeps out in many weird and interesting ways, from the crevices and corners of buildings and bridges, from underneath and from above, and the streets at night are a mass of twinkling colours reminding us all that we rarely get beyond five years of age and ever take delight in childish things. Of course, illuminating engineering, as seen by Mr. Seki, comprises a great deal more than lights for streets and buildings. He tells us of the "canary lamp," used extensively in sericulture; neon tubes and mercury arc lamps in big demand; studies in human ocular functions—"It is found that the visibility curve of the average Japanese eye coincides with that of foreigners, despite the apparent colour difference between them, and it is verified that the curve shifts towards the longer wave with the age"—finally, the use of electrical illumination in connection with the photo-galvanic cell and other apparatus.

The foregoing survey of the Abstract of Papers by no means includes reference to all the papers submitted, itself not containing a complete list. It is hoped, however, it will serve to give an indication of the extraordinary extent and variety of the papers prepared for the Congress by engineers of many nationalities, chemists and research workers. As already stated, the papers are to be published in volume form at the end of March.

THE LIGHTER SIDE.

It would take many pens to report adequately the doings of the Congress (and his lady) in the unofficial hours. Every day there was something "on," and the noon and evening hours were invariably taken up with functions not unrelated to feasting. The President's reception on the eve of the opening of the Congress was memorable, a gathering of between a thousand and fifteen hundred people, in the banqueting hall of the Imperial Hotel, of a style and architecture not in the remotest sense suggestive of the people and country to whom many of the visitors were complete strangers and who would have preferred the scene to have been completely and wholly Japanese and Oriental. But so it was and so is not to be. Foreigners will never cease talking of the beautiful that is old, and, by inference, condemning the ugly that is new; but the leaders of the people are unalterably set in their modern course; the traditions and romance of the past are put away in the family godown, like the treasures of the godown, to be brought out and worshipped occasionally, on holidays and great festivals. Each day had its occupation of lighter sort, to which the whole of the Congress (and his lady) were invited, while others were attended by groups and sections, some for men only and others for women only. The chief events were the visit *en masse* to the great Meiji Shrine; the Imperial garden party, and parties at the residences of one or two magnates of the city, whose names stand for, not only wealth, but for all that is modern and enterprising in the Japan of to-day.

Every loyal Japanese, visiting the Imperial capital, will not fail to make his devotions at Meiji Shrine; as a necessary preliminary, purifying himself with water at the entrance to the outer shrine, and proceeding to the inner shrine, where he will worship the shade of the departed great Emperor, who joined the Imperial ancestors in 1912, reverenced as the greatest of the nation's rulers. It is now the custom for all to visit, native and foreign, singly and in groups, and on holidays hundreds of thousands will be seen there. To strangers from foreign lands it is an experience not to be forgotten, for everything about the Meiji Shrine speaks of the Japan that seems to have passed, and the pilgrim is in another world. The shrine buildings are in the simple Shinto style, chaste and beautiful, but not impressive to those accustomed to St. Peter's or Westminster Abbey—enduring monuments of stone. The grounds surrounding the shrine contain every tree and shrub known to Japan, and the wonderful torii at the main entrance, two in number, are fashioned out of colossal trunks of trees, camphor trees from Formosa, many feet thick at the base and straight as a die. Adjoining the shrine, but half-a-mile away, is a memorial hall, its walls to be hung with oil painting depicting the main events in the late Meiji Emperor's career. The paintings are only partially completed. In the specially laid-out Meiji grounds are a huge stadium for games and an athletic track, where young Japan is making a name for itself in all branches of sport, which only a few short years ago were condemned as being among the curious evidences of madness of the Western barbarians. Great is the transformation of the people—almost unbelievable to men not yet old.

The function at the Shinjiku Imperial Gardens will ever be remembered as a perfect day spent amid the beauties of cultivated Nature. A St. James's Park three times the size. The care that is shown in all Japanese gardens in the planting of trees and shrubs, the beautiful blending of colour, and the glorious sunshine over all. Prince Chichibu, the heir-presumptive to the throne, familiar with Oxford, and his consort, English-born, educated in China, with finishing touches in America—what influence will the two not have on the future of Japan! The Prince and Princess received the leaders of the delegates and their ladies, and there was much affability and no restraint.

On another day, the garden party given by Baron Mitsui, which included performances of the No on an imposing stage specially erected for the Prince of Wales during his visit in 1921. A performance, the like of which was never seen before by many, and among these many must be included the modern Japanese, who is coming to know less and less of the things of his native country that are worth preserving; another day, garden party at the residence of Baron Iwasaki, another financial magnate, when the guests carried away as souvenirs small examples of the potter's art, bearing decorations of their own design, when nine out of ten found themselves lamentably deficient in ideas and with complete inability to put their ideas into artistic form. The machine age. The guests worked on unglazed pottery, which was finished by the potter and baked. It is a common and very pleasing form of entertainment on such distinguished occasions.

There were the official functions, and semi-official, given by the Premier, which was the first, and by the Mayor, which was the last. And many private affairs, dinners at the respective embassies and legations, and finally the entertainment of the British delegates and some of the residents by the leaders of the British group—Messrs. E. F. C. Trench, R. W. Allen, Sir A. Gibb, F. Gill, Sir R. Threlfall, W. J. E. Binnie, W. Reavell, and J. M. R. Fairbairn. This, a dinner and entertainment following, was of a more intimate character. Mr. Trench proposed "The Emperor" and Sir Richard Threlfall "The King." Thereafter, some juggling by Japanese, of a marvellous order, and story telling by all, from A to Z. The best story had some connection with the English language, and was told by a Canadian. A Cockney was in the washroom of a Pullman train approaching Buffalo, when a native entered and, looking through the blurred window, shouted: "Where are we at?" "In our country," returned the Cockney with dignity, "we says, 'Where is my 'at.'" The prize went to the Canadian.

Before the evening was over there was a subscription to be handed to the Mayor for the poor of Tokio.

On the eve of departure from the capital, on visits to other sights and scenes in the provinces several of the guests expressed their thanks and pleasure in letters to the papers. One from a lady, signed Ruth Randall Edstrom, expressed thanks to the Japanese ladies one and all for the courtesies with which the visitors had been overwhelmed. The irrepressible Senator Luigi Luiggi, who so startled the Congress at the opening ceremony, wrote as follows on behalf of his Italian colleagues:—

> "The Italian Delegation to the World Engineering Congress is in admiration at the intensive agriculture of Japan, its beautiful landscapes and temples, its ancient culture; but especially we are in admiration of its modern universities and institutes of scientific researches, of its factories and shipyards, of its perfectly organised railways and means of communication by rail, sea and air.
>
> "All this promises to Japan the most bright and prosperous future and to its Government and to its people an era of peace, of plenty, and of glory.
>
> "All my Italian colleagues join with me in a heartfelt cheer of 'To Japan . . . Banzai!'"

(To be continued.)

Steamships and Steam Marine Engineering in 1929.

No. II. (*Conclusion.*)*

Types of Propelling Machinery.

Geared Turbine Installations.—The brief account of the principal large steamships constructed during 1929, which was given in our last issue, indicated clearly the large number of geared turbine installations which were completed and the advance made in the direction of utilising higher steam temperatures and pressures. A feature of the year was the steady progress of the Parsons marine steam turbine, both at home and abroad. At the Wallsend works of the Parsons Marine Steam Turbine Company, Ltd., 73,000 S.H.P. of geared marine steam turbines was constructed and the firm supplied 14,300 S.H.P. of mechanical gearing and cut 88,000 S.H.P. of gearing for its licensees. At the annual meeting of the company Sir Charles Parsons referred to the continuation of research for higher turbine efficiencies. At Clydebank John Brown and Co., Ltd., built several sets of Brown-Curtis turbines for mercantile and naval ships.

* No. I. appeared January 3rd.

Turbo-electric Propulsion.—In our last issue reference was made to the successful operation of the turbo-electrically propelled P. and O liner the "Viceroy of India," and to other ships which are to be engined with turbo-electric machinery designed and constructed by the British Thomson-Houston Company, Ltd., of Rugby. Good progress was made in the new field of exhaust and mixed-pressure auxiliary turbo-generator sets used in conjunction with an auxiliary propelling motor mounted on the propeller shaft. Typical installations completed by the British Thomson-Houston Company, Ltd., and the Metropolitan-Vickers Electrical Company, Ltd., were referred to in our last issue. With the increasing importance of electrically operated auxiliary machinery, auxiliary electric propulsion schemes offer many possibilities in the direction of increased fuel economy.

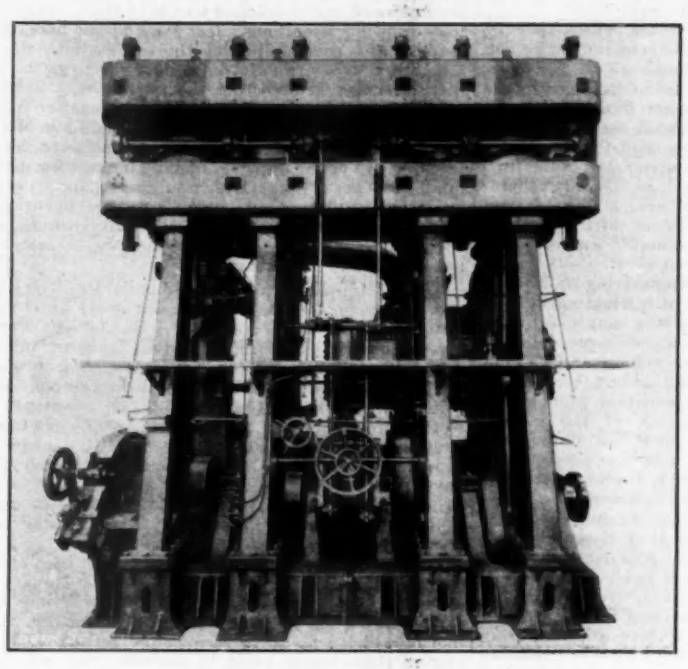


FIG. 10—2200 I.H.P. LENTZ MARINE ENGINE

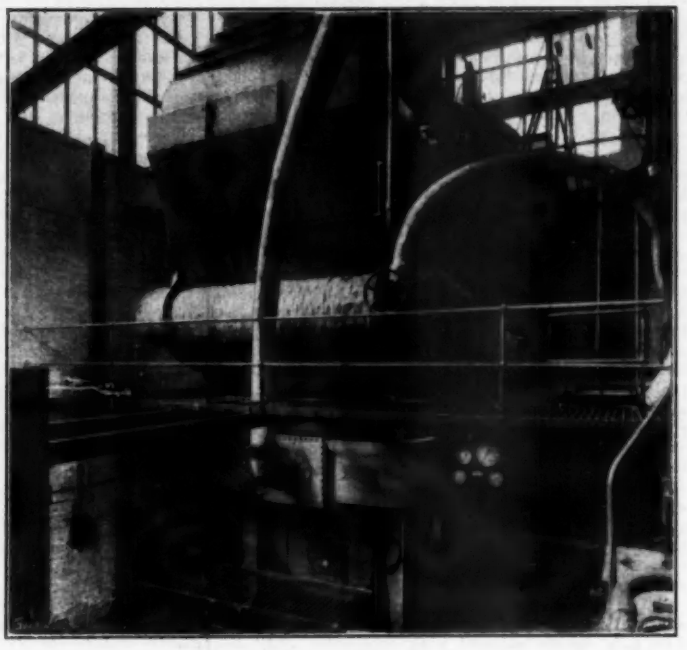


FIG. 11—1200 LB. PRESSURE YARROW EXPERIMENTAL BOILER

FIG. 12—550 LB. PRESSURE BABCOCK AND WILCOX BOILER

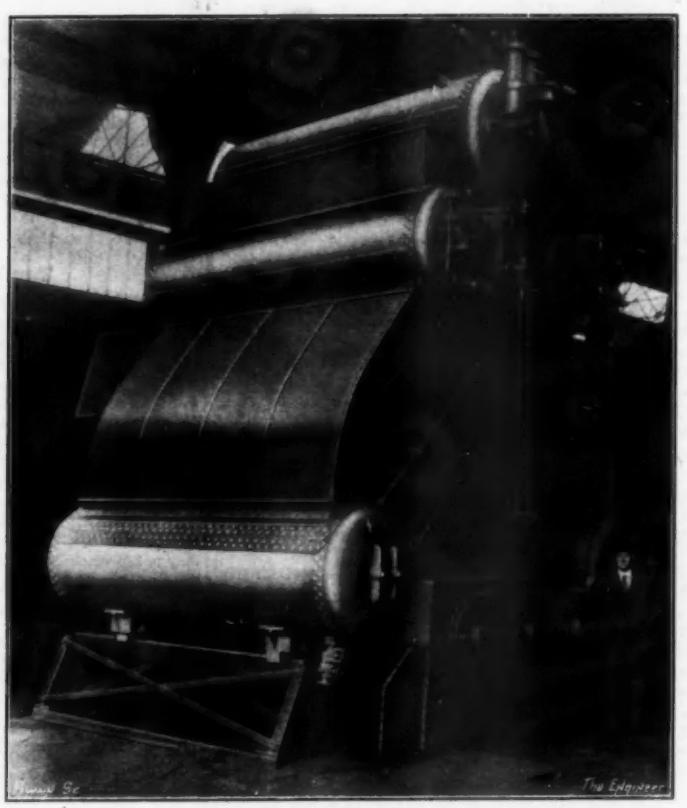


FIG. 13—210 LB. PRESSURE HAWTHORN-ARMSTRONG BOILER

The Reciprocating Steam Engine.—Although an advance was made in turbine propulsion, there was no marked decrease in the number of reciprocating steam engines built in 1929, and the development of this type of propelling machinery was stimulated by the utilisation of higher steam temperatures and pressures and new types of valve gear. The successful employment of marine steam turbines in conjunction with reciprocating engines by means of appropriate mechanical or electrical transmission to the propeller shaft was a field in which great progress was made. On the Clyde, David Rowan and Co., Ltd., completed twenty-nine sets of triple and quadruple-expansion engines aggregating some 72,800 I.H.P., while at Greenock John G. Kincaid and Co., Ltd., supplied fifteen sets of marine steam engines aggregating 23,940 I.H.P. At the Wallsend and Sunderland works of the North-Eastern Marine Engineering Company, Ltd., twenty-eight sets of triple and quadruple-expansion engines were delivered, twelve of which were specially designed to use superheated steam.

The output of the Central Marine Engine Works at West Hartlepool was the highest since the founding of the works in 1883. It included twenty-one installations of steam engines, aggregating about 69,000 I.H.P., of which over 25 per cent. were quadruple-expansion engines designed for high-pressure and high-temperature steam.

At the Sunderland works of John Dickinson and Sons, Ltd., several sets of engines were completed, including a 2200 I.H.P., 70 r.p.m. Lentz engine, shown in Fig. 10. This engine has two 22in. high-pressure cylinders and two 47½in. low-pressure cylinders with a common stroke of 47½in. It is

designed to work with a pressure of 210 lb. per square inch and a total steam temperature of 620 deg. Fah. It was installed in the "Rajahstan." The Lentz engine, which was fitted into the cargo steamer "Holystone," belonging to the same owners, has done well, and a late examination of the valves and spindles showed no sign of wear. On a recent voyage from Montreal to Rotterdam with 9000 tons of cargo the "Holystone" made an average speed of 9 knots from port to port on a consumption of only 21 tons of ordinary North Country coal per day for all purposes. During the year several conversions to Lentz valve gear with increased steam temperatures and pressures and with feed heating were carried out for British and foreign owners by the Lindholmen-Motala Company, of Gothenburg, and in all cases a saving of 25 per cent. in coal consumption was guaranteed.

Exhaust Geared Turbine Installations.—Noteworthy progress was made with exhaust turbine installations coupled by gearing to the reciprocating engine and driving the propeller shaft through a hydraulic coupling of the Bauer-Wach type. One of the largest 1929 Bauer-Wach programmes was that carried out by William Beardmore and Co., Ltd., and R. H. Green and Silley Weir, Ltd., on the "B" class liners of the P. and O. Branch Line. The ships "Ballerat," "Balranald," "Bendigo," "Baradine" and "Barrapool" were all equipped with the Bauer-Wach exhaust turbine drive and were converted to oil firing, the "Wyndham" system of exhaust feed heating also being installed. The original 7000 I.H.P. machinery gave a sea speed of 13 knots with coal firing and that output has now been increased to 8400 I.H.P. for engines and turbine equipment, corresponding to a service speed of 15½ knots with oil-fired boilers. In the Wyndham system the exhaust steam from the auxiliaries is superheated by passing it through a series of headers placed in the boiler uptakes. When superheated it may be utilised in turbines or may be employed in surface type heaters to raise the temperature of the feed water to 250 deg. to 260 deg. Fah. The largest vessel converted by William Beardmore and Co., Ltd., was the P. and O. liner "Comorin," in which the original output of 11,000 I.H.P. was increased to 13,000 I.H.P. by adding the exhaust turbine drive. At Dalmuir no less than twenty-five exhaust turbine sets were built, sixteen being for converted ships and nine for new vessels. Sufficient work is in hand to keep this department at Dalmuir busy during the first half of 1930. William Beardmore also delivered three sets of Caprotti valve gear, two of which will be employed with large four-cylinder triple-expansion engines of 5000 I.H.P. in conjunction with the exhaust turbine drive. At Wallsend, Swan, Hunter and Wigham Richardson, Ltd., also finished three sets of Bauer-Wach turbines.

Marine Boilers of 1929.

The Yarrow Water-tube Type.—In our first article we mentioned some of the new liners in which high-pressure Yarrow boilers are used. They include the C.P.R. steamers of the "Beaver" and "Duchess" classes and the P. and O. liner "Viceroy of India." High-pressure Yarrow boilers are also under construction for the two Clyde-built C.P.R. liners of the "Empress" class. In the last three years Yarrow and Co., Ltd., have designed boiler installations aggregating over 1,000,000 square feet of heating surface for installations in passenger and cargo ships. The firm was recently successful in obtaining the order for designing the large boiler for the new Lloyd Sabaudo liner which will be built in Italy. In an interesting paper recently read by Mr. A. L. Mellor before the Institution of Engineers and Shipbuilders in Scotland, the statement was made that the average service efficiency of the Yarrow boilers on the "Viceroy of India" is 85 per cent. The furnace refractories proved to be very durable, while repairs and replacements were very small. In the latest Yarrow designs boiler pressures of 425 lb. per square inch with a total steam temperature of 725 deg. Fah. are being worked to. It is well known that Yarrow and Co., Ltd., have under construction for a patentee a novel type of water-tube boiler in which the combustion space is entirely surrounded by tubes. The object of the new design is to provide a marine boiler of the water-tube type which will burn either oil fuel or pulverised coal and which, while having a very high efficiency, will be cheaper to construct, lighter in weight, and which will occupy a smaller space than marine boilers hitherto constructed. The heat transmission rate at the fire row tubes is low and therefore great durability may be expected. One unit of this new type, which is already built, will be installed with 425 lb. pressure Yarrow type boilers in a large Clyde-built passenger liner, and a second unit now approaching completion at Scotstoun will form one of three boilers in a fast steamer of the cross-Channel type, also under construction on the Clyde. In Fig. 11 we show a view of the 1200 lb. pressure experimental Yarrow boiler installed in the firm's Scotstoun works.

The Babcock-Wilcox Water-tube Type.—In last week's article we mentioned the Babcock and Wilcox boiler installations on the Holland-America liner "Statendam" and the cross-Channel steamer "Canterbury." Another interesting high-pressure boiler installation of this type put into service in 1929 was that of the Clyde passenger steamer "King George V.," engined with high-pressure Parsons turbines. A view of one of the two boilers is reproduced in Fig. 12. It has a designed working pressure of 550 lb. per square inch with a steam temperature of 700 deg. Fah. at the superheater outlet. The boilers are of the usual Babcock design, each boiler having a width of eighteen sections with tubes 9ft. 3in. overall length. Each boiler has a tube heating surface of 2280 square feet, a superheater tube surface of 780 square feet, an air heater surface of 800 square feet, and a grate area of 75·5 square feet. The boilers are designed for burning coal and are hand fired on the closed stokehold system of forced draught. The general steaming of the boilers was easy and normal. As recorded in our issue of July 26th, 1929, however, there was, on July 19th, a regrettable accident caused by the failure of some tubes in the forward boiler, which led to a partial re-tubing of that boiler. It was later shown that the tube failure was directly caused by lack of water in the boiler.

The Howden High-pressure Boiler.—During last summer Alexander Stephen and Sons carried out tests at Linthouse on an experimental unit of the Howden combined cylindrical and water-tube boiler built for a pressure of 350 lb. per square inch. While the ability of the boiler to work with salt water mixed with the feed without priming, arrangements were made to steam the boilers with a 13 per cent. salt solution, and with this solution no priming took place even under full-power conditions. At half power equally good results were obtained with a 33 per cent. salt solution. The tests of a sister boiler fitted with a superheater are given below. These trials were

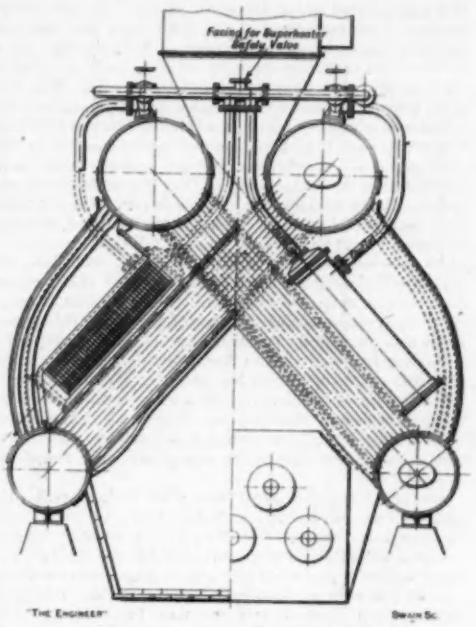


FIG. 15—HAWTHORN-ARMSTRONG BOILER

carried out with cold air. This boiler has a generating heating surface of 3400 square feet, with a superheater surface of 569 square feet, and a combustion chamber volume of 374 cubic feet, and is designed for a working pressure of 210 lb. per square inch. The oil burners are of the "Laidlaw-Drew" type, in which, in addition to the air supplied by the fan, have a small jet of compressed air is led to each burner. During the trial runs the furnaces were found to be remarkably clean, with freedom from any deposit of carbon.

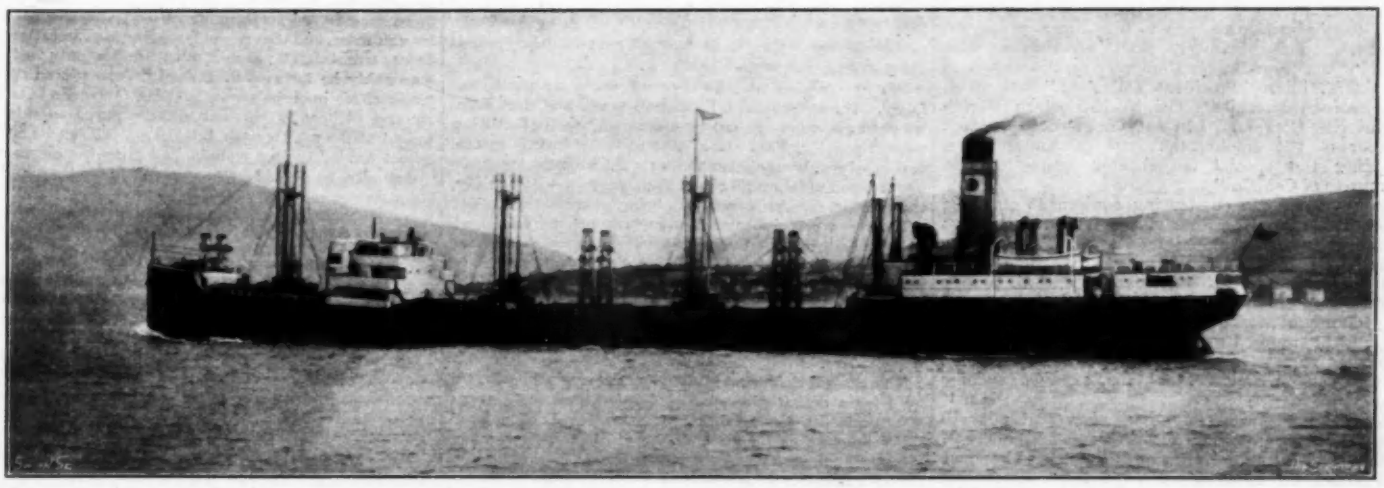


FIG. 14—THE PULVERISED-COAL-BURNING COLLIER S.S. "BERWINDLEA"

The following is a summary of the results of the trials carried out on December 16th and 17th last:—

Hawthorn-Armstrong Boiler Trial Results.

	Natural draught.	Forced draught.
Boiler pressure, lb. per sq. in.	207	204
Temperature of superheated steam, deg. Fah.	512	511
Feed temperature, deg. Fah.	107	102
Water evaporated per hour, lb.	16,225	33,450
Oil temperature at burners, deg. Fah.	204	200
Oil pressure at burners, lb. per sq. in.	48	55
Oil fuel burnt per hour, lb.	1,466	2,823
Calorific value of oil (net), B.Th.U. per lb.	18,286	18,286
Air temperature at burners, deg. Fah.	52	73
Air pressure at burners, in.	—	13/16
Funnel temperature, deg. Fah.	610	750
Boiler efficiency with unheated air, per cent.	72·3	77·5

Boilers of the Hawthorn-Armstrong type are giving good results in the whaling ship "Norona" and the high-pressure Dutch steamer "Borneo."

Pulverised Coal Burning Progress.—One of the interesting ships of the year was the "Berwindlea," shown in Fig. 14, which was fitted with Clarke-Chapman pulverised coal equipment. She was built to the order of the Berwindmoor Steamship Company by the Blythswood Shipbuilding Company,

Ltd., of Scotstoun, and engined with 2300 I.H.P. triple-expansion machinery by David Rowan and Co., Ltd., of Glasgow, under the supervision of Esplen and Sons, Ltd., of Liverpool. The whole of the bunker space is hoppered and leads direct to the coal feeds to "Resolutor" pulverisers. Only one fireman is needed to attend to the six furnaces of the two boilers during each watch. The trials of the ship showed that a speed of 11·5 knots could be obtained, the guaranteed speed being 10 knots. In service the average fuel consumption was 23 tons per day for all purposes at an average speed of 9·75 knots, with a deadweight carrying capacity of 7500 tons, as against 34 tons for a similar ship hand fired. The ship has now steamed some 15,607 miles and the pulverising plant has given no trouble. During the year Clarke, Chapman and Co., Ltd., made improvements in the "Woodeson" short-flame burner and the ring main distribution system, incorporating a new type of coal valve and secondary air control lever. Plants were also supplied for the North German Lloyd steamer "Donau" and the Rhine tugboat "Metz."

In our issue of August 2nd, 1929, we described the "Brand" powdered fuel equipment of the Ropner Line cargo ship "Swiftpool." The boilers of this steamer were originally arranged for hand firing and some modifications were necessary. The "Swiftpool" will shortly return from her second voyage. Good progress was made with the Howden-Buell system of pulverised fuel burning, and the success obtained with the "Hororata" decided her owners to fit the whole of her boilers with powdered fuel burners. Two new cargo ships are also to be equipped with the same system.

On the Clyde, Yarrow and Co., Ltd., carried out exhaustive experiments with British coals and equipped boilers on the Henderson liner "Amarapoora" with the Yarrow pulverised fuel system. The liner is now completing her first voyage, and valuable results have been obtained. Part of these experiments were carried out on the 1200 lb. pressure experimental boiler illustrated in Fig. 11. At Renfrew, Babcock and Wilcox carried out experimental work on pulverised fuel burning.

Superheating and Condenser Progress.

The Sugden type of uptake superheater for Scotch boilers was fitted to several ships during the year, including the cargo liner "Dee Bank" and the whale oil factory "Kosmos." Service results indicated that a steady superheat of 100 deg. Fah. and a little over was obtainable with this type of superheater, and that in no case has a superheater unit been replaced.

During 1929 satisfactory experimental work was carried out with superheaters installed in the combustion chambers of Scotch boilers, and it seems likely that a further advance in this direction may be expected. The separately fired superheater unit built by the Superheater Company and installed in the C.G.T. liner "President Dal Piaz" has given very successful results. The North-Eastern Marine Engineering Company, Ltd., also constructed a large number of the smoke-tube type of superheaters, including the special superheater units for the "Empress of Canada."

Improvements in condensing equipment continue to be made along the lines of the Weir regenerative condenser with the closed feed system, which was installed on several ships along with turbine-driven feed pumps. New turbo-feed pumps and air pumps were fitted to the "Mauretania" with greatly increased the economy of working. The Mirrlees-Watson Company, Ltd., supplied designs for several sets of Mirrlees-Delas surface condensers and also built steam ejector vacuum augmentors for exhaust turbine arrangements.

From the outline we have been able to give it will be seen that progress was recorded in all branches of marine engineering activity, and that the experience thus gained will enable British shipbuilders and marine engineers to cope successfully with the largest British liners which the future will undoubtedly demand.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

MISLEADING MATHEMATICAL PHRASEOLOGY.

SIR,—In some of your recent issues there has been a discussion as to the physical dimensions of temperature, and in your issue of October 18th, 1929, a letter from a correspondent contained two definitions of specific heat quoted below:

". . . The amount of heat required per degree to raise the temperature of unit quantity of the substance under any assumed mode of heating.

"The heat capacity of a substance is the heat per unit mass per degree of rise required to produce a very small rise in temperature."

My object in calling attention to these two definitions is to protest as violently as I can against the abominable misuse of the word "per" contained in them, and to suggest that this misuse, so common throughout science, is responsible for much of the confusion of thought so typically displayed in your recent correspondence.

In the first place, you will see that "specific heat" and "heat capacity" are treated as synonymous. They may be so; but it is more usual to treat specific heat as a ratio between the heat capacity of a given substance and the heat capacity of a standard substance such as water. The failure to make this distinction was at the bottom of much of your correspondence.

But leaving out this slack use of the terms, let us examine the wording of the first definition.

Is the expression "per degree" synonymous with "in one degree"? And, if not, what does it mean?

What has "unit quantity" to do with the question? Surely we can determine specific heat by dealing with any quantity.

Then let us read through the definition—assuming that "per degree" means "in one degree"—and try to determine the physical dimensions. Specific heat is clearly an "amount of heat"; it is of the dimensions of energy. The definition says clearly that is the amount of heat required to raise a certain quantity of the substance through a certain rise in temperature.

Coming to the second definition, we again strike against the customary vague use of the word "per." Translating it as before, we again find that heat capacity is an amount of heat. But we are now faced with another difficulty. We are told to take a rise of one degree and also to take a "very small rise."

The author of the definition may claim that I have mistranslated his word "per." If so, what is the correct version? If "per degree" does not indicate some special significance of the degree, why does the word degree appear at all?

The heat capacity of a substance—as distinct from the heat capacity of a specified body—is calculated by giving an amount of heat to an amount of the substance, and observing the rise in temperature. No other physical quantities are concerned, and we may accept the custom of taking mass as a criterion of the amount of the substance, although this mass is not necessarily the same thing as Newtonian mass.

Whatever definition we may give these three physical quantities must appear, and, moreover, they must be treated with the exact same amount of respect. If the units are to be specified in one case, they must be specified in all; if we are to talk of unit temperature and unit mass, then we must say something about unit heat.

On the other hand, if we prefer not to be tied down to any particular set of units we may omit the word unit from all the quantities, and deal merely with the physical quantities concerned.

We pass heat to a body of known mass; note the amount of heat and the corresponding rise in temperature.

For this particular set of readings—taken under certain known conditions—we can say:

$$\text{Heat capacity of substance} = \frac{\text{Heat absorbed}}{\text{Mass} \times \text{Rise in temperature}}$$

And we can agree to write this colloquially in the form—

Heat capacity is the (heat absorbed per mass heated) per rise in temperature.

We are free to use whatsoever units may suit our fancy. If we take B.Th.U., pound mass, and deg. Fah., we shall get our heat capacity as so-and-so (B.Th.U. per pound) per deg. Fah. Unit heat capacity in this system is that of a substance demanding x B.Th.U. for the heating of y pounds through z deg. Fah., where $x \div y\,z$ is unity, the simplest case arithmetically being where each is unity.

If over a certain range of temperatures the values are independent of the temperatures, we say the thermal capacity is constant within this range. Incidentally, the whole method of measuring the capacity is based upon the assumption that the values are independent of the amount of the substance used. We assume that b times the mass will require b times the amount of heat for the same rise in temperature.

The general definition given above covers all cases. If we take a definite interval of temperature, we get the mean capacity corresponding to that interval; if we need the value at a particular temperature, we must calculate the rate at that particular temperature.

For example, if we introduce the familiar calculus notation, the formula might appear in the shape—

$$\text{Heat capacity of substance} = \frac{\delta H}{M \times \delta T}$$

The rate $\delta H/\delta T$ might be worked out in B.Th.U. per deg. Fah.—the capacity of some particular mass M—and then divided by M to give the capacity of the substance.

The method advocated in the above remarks may be open to the criticism that we have no right to speak of multiplying and dividing when we deal with physical quantities, and that these terms must be reserved for numbers only.

But this is a matter of definition, and the term numbers has already been extended to include fractional and negative "numbers," by the simple process of extending the meaning so as to include these mathematical abstractions. The claim to membership of the select society of numbers is based entirely upon the fact that the new members obey the rules laid down by the original members—the positive integers. In just the same way, words signifying physical quantities may be given full membership and they will obey the laws of $+$, $-$, $\times$, $\div$ with perfect regularity. The word "per" becomes exactly equivalent to the symbol $\div$, and should be reserved entirely for this meaning.

The method is old, and will be found in Professor Everett's "Units and Physical Constants," published in 1879. Recent interest in it has been much fostered by the teaching of Dr. William Stroud.

The generality of the method is illustrated in the present example by the introduction of foot-Lb. as a unit of heat—the symbol Lb. stands for the force that will produce an acceleration of 32·2ft./sec.^{2} in a mass of 1 lb.; hence Lb. $\div$ lb. may be denoted by the symbol g, a constant acceleration independent of the units in which it is expressed.

$$\text{Heat capacity of substance} = \frac{\text{Heat absorbed}}{\text{Mass} \times \text{rise in temperature}} = \text{say, } x \times \frac{\text{ft. Lb.}}{\text{lb.} \times \text{deg. Fah.}} = x \times g \times \frac{\text{ft.}}{\text{deg. Fah.}}$$

where x is purely numerical.

This particular form will be found useful in dealing with the familiar law—

$$p\,v = R\,T.$$

R is of the dimensions of heat capacity, and R T is energy per mass; p is force per area; v is volume per mass; hence $p\,v$ is also energy per mass.

It will be noticed that the dimensions of temperature do not enter into the calculation, although there may be some philosophic interest in speculating upon the possibility of some connection between temperature and the fundamental quantities of mechanics.

May I repeat the main argument I have advanced, taking the case of heat capacity as typical of all rates?

Heat capacity is measured with reference to three other physical quantities that are already measurable—mass, heat, and temperature.

The heat capacity of any specified body is the heat added per rise in temperature—a rate that might be expressed in terms of 1 (B.Th.U. per deg. Fah.) or 1 (foot $\times$ Lb. per deg. Fah.).

It is natural to assume that the heat required is also proportional to the mass of the body and hence for any particular substance the capacity of the whole body must be divided by the mass. We get, then, that the heat capacity of a substance is (heat added per rise in temperature) per mass; or, if preferred (heat added per mass) per rise in temperature.

This definition is complete. It is general and outside any system of units. So long as we are given our three quantities—heat, mass, and temperature—we put them in as they are given, and let the units look after themselves.

Moreover, we can alter our units from any system to any other by the introduction of "reducing factors," each equal to unity, so arranged as to allow the unwanted words to cancel out.

In conclusion, may I quote an example from a well-known text-book to illustrate the grave danger of the present misleading use of units?

The text-book states that for air R = 53·3 foot-pounds. The reader wishes to convert the constant for use in the metric system; he converts feet to metres, pounds to kilogrammes, and——! Obviously, the author has got quite accustomed to thinking of heat capacity as energy for unit mass, and unit rise in temperature. In other words, he has translated "per unit mass" in the only way it can reasonably be translated. Indeed, in the preceding paragraph of his book he states that the "specific heat is the amount of heat in thermal units required to raise unit weight of the gas through 1 deg. Fah." Then he converts "heat units" to foot-pounds, and gives the above result.

Actually, he should have stated that the required constant was—

$$R = 53{\cdot}3\ \frac{\text{ft. Lb.}}{\text{lb. deg. Fah.}}$$

If we want to convert to the metric system, we must convert feet to metres (1 m. = 3.28ft.) and deg. Fah. to deg. Cent. (180 deg. Fah. = 100 deg. Cent.); Lb./lb. can be replaced by Kg./kg., since in both cases the value is g.

$$R = 53{\cdot}3 \times \frac{\text{ft. Lb.}}{\text{lb. deg. Fah.}} \times \frac{\text{metre}}{3{\cdot}28\text{ft.}} \times \frac{180\text{ deg. Fah.}}{100\text{ deg. Cent.}} = \frac{53{\cdot}3 \times 180}{3{\cdot}28 \times 100} \times \frac{\text{metre} \times \text{Kg.}}{\text{kg.} \times \text{deg. Cent.}}$$

The numerical factor may now be worked out, and R still remains general and still (energy per mass) per temperature. The whole conversion has been made in strict accordance with the rules and regulations of mathematical manipulation.

S. H. STELFOX.

Monkseaton, January 2nd.

NEW ROAD AND RAIL BRIDGE IN NEW SOUTH WALES.

SIR,—In the first paragraph of an article headed "New Road and Rail Bridge in New South Wales," on page 234 of your issue of August 30th, 1929, the following statement, which is incorrect, occurs:—"Curiously enough, the main fixed spans are not all of the same length, though there does not seem to be any reason why they should not be."

The dimensions that you have shown on your elevation are from centre to centre of piers, and there are sound structural reasons for these dimensions being different, even for the piers supporting the main fixed spans; but, as a matter of fact, the truss spans are identical in length, namely, 240ft. centre to centre of end pins.

I am directed by my Commissioners to request that you will be good enough to publish a statement correcting the original article.

W. JNO. MORRIS,
Secretary to the Commissioners,
New South Wales Government Railways and Tramways.

Sydney, November 29th, 1929.

SIXTY YEARS AGO.

A CONSIDERABLE amount of interesting information of a miscellaneous character is to be gathered from our issue of January 14th, 1870, some of it tantalising in its brevity. We would have liked to have heard more, for instance, of the German astronomer who, we informed our readers, stated that we were soon to have another moon, and that it would be nearer to the earth than our present satellite. More information would also have been welcome concerning the discovery of another German, a pupil of Baron Liebig, who, we recorded, had found certain ethers which, when poured upon some chemical compounds, instantaneously produced precious stones of all kinds. From a journalistic point of view something more might have been made of the fact that during the past week the trigonometrical survey of England and Wales on a scale of 1in. to the mile had been completed. We contented ourselves with recording the interesting fact that this survey had been begun in 1791. In Poplar coming events were even then casting their shadows in advance. We read that up to a few days before the date of our issue the workmen of Poplar had entertained general hopes that the contract for building two new mail boats of 3000 tons and 600 horse-power required by the Peninsular and Oriental Company would be placed with Thames-side shipbuilders. Great surprise and disappointment were expressed when it was learned that the tender of Messrs. Caird, of Greenock, had been accepted, and that it was more than £20,000 below that of the Poplar shipbuilders. In another direction a prognostication of what was to be was contained in a brief note which we published. The use of falling water as a motive power on the Mont Cenis tunnel works had suggested, we wrote, the extensive employment of such power. Switzerland, we noted, was especially favoured in this respect. It possessed an immense store of water power which was then running to waste, but which engineering skill could turn to the account of manufacturers. In London, we read, some delay had occurred in carrying out the works entered upon by the Metropolitan Street Tramway Company. Good progress was, however, likely soon to be made. A very favourable contract had been entered into for the supply of 400 tons of rails and joint plates. Sufficient timber for the construction of the whole line had been contracted for, and of eight carriages ordered in New York one had been delivered. The company, we noted, was working on terms of amity with all the local authorities.

B.E.S.A. SPECIFICATIONS.

TESTING TIMBER.

THE British Engineering Standards Association has just published a British Standard Specification for Methods of Testing Small Clear Specimens of Timber, No. 373—1929, for the purpose of comparing the mechanical properties of one species of timber with another. The specification covers the standard methods of carrying out the following tests:—Moisture content, compression, static bending, impact hardness, cleavage, shear tension, specific gravity and shrinkage, and includes a table showing the tests recommended to indicate the suitability of timber for specific uses. The Association has worked in close touch with the Forests Products Research Laboratory in the preparation of the specification. Further experiments are being carried out by the Forests Products Research Laboratory, to determine a standard method of drying specimens of timber, which will be submitted for the consideration of the Committee responsible for the specification when the specification is revised, with a view to drawing up more comparable determinations for shrinkage and specific gravity. The methods included in the present specification have been, however, generally adopted, and are producing useful results.

OIL-IMMERSED SWITCHES AND CIRCUIT BREAKERS.

THE British Engineering Standards Association has just issued a revision of British Standard Specification No. 116, which deals with oil-immersed isolating switches, oil-immersed switches, and oil-immersed circuit breakers, the distinction between these classes of apparatus being defined by a statement to the effect that an isolating switch is intended only for interrupting circuit when there is no load current, a switch being suitable for breaking a load current, and a circuit breaker being suitable for interrupting a circuit in abnormal conditions, such as that of short circuit. In the preparation of this revision due regard has been given to similar work done in other countries, with a view to co-operation in international standardisation. The specification is intended to cover indoor circuit breakers up to 33,000 volts, and outdoor types up to 220,000 volts. Useful appendices are included, giving notes on the care and maintenance of circuit breakers, and also on the measurement of voltage and sphere gaps.

Copies of the specification may be obtained from the British Engineering Standards Association, Publications Department, 28, Victoria-street, London, S.W. 1, price 2s. 2d. post free.

INDUCTION FURNACES—CORRECTION.

AN unfortunate slip occurred in the make-up of the second article on Induction Furnaces in our issue of December 27th, a paragraph being accidentally misplaced. This paragraph begins at the foot of column one on page 681 and finishes in column three of the same page. The whole of this paragraph refers to the Ajax-Wyatt furnace of the Electric Furnace Company, Ltd., and should have formed the conclusion of the first article, page 654 of our issue of December 20th. We apologise to the Electric Furnace Company, Ltd., for the mistake.

Progress in Marine Engineering.*

By ENG. VICE-ADMIRAL R. W. SKELTON, C.B., C.B.E., D.S.O., Member of Council.

THE bewildering variety of marine engine types and designs now available springs from the same motives that have always existed during the application of mechanical power to the propulsion of ships. It will, I think, be of interest, therefore, to trace in broad outline the principal developments since early days, so far as can be done within the compass of a lecture of this description. A consideration of the reasons leading to changes from time to time, of the successes and, above all, of the failures, particularly those failures which later "came back," may, indeed, assist us to view in a better perspective the significance and promise of the modern advances and trends. In any case, and apart from the technical issues, the high endeavour of our predecessors affords an example whose study can hardly fail to stimulate our efforts at the present stage, when further very substantial advances in progress are resisted by what appear to be great difficulties.

The later history is known to all interested in such matters, but I think the early events have not been so widely recorded, and I will therefore dwell on the opening developments.

Although an engine had been ordered by the Admiralty from Boulton and Watt for the sloop "Congo" in 1815—subsequently found to be too heavy, and in consequence removed and fitted up on shore instead—and a number of small auxiliary vessels in the Admiralty service had used steam engines primarily at the instigation of Brunel from 1816, it was not until March, 1828, that the name of a steam vessel appeared in the Navy List. This was the "Lightning," of 100 nominal horse-power, which was built at Deptford, and completed in December, 1823. The decision to build a steam fighting ship resulted in the laying down of H.M.S. "Dee," of 200 nominal H.P., at Woolwich in 1829. From then on, the use of steam slowly extended. The advantage of steam for a fighting service was made reasonably obvious during the Syrian Campaign in 1840, and by the time the Crimean War finished it was a somewhat grudgingly accepted means of auxiliary propulsion, even for the ponderous line of battleships.

As might be expected, the early days of the transplanting of the steam engine and boiler to service afloat were filled with difficulties, disappointments, and failures. In the naval service, difficulties were experienced in respect of *personnel* as well as material, and considering the rigidity of naval discipline at that time, the reason can well be appreciated; those unwelcomed interlopers, the enginemen, were recruited direct from the benches and forges of the engine shops, and, undisciplined, came and went as they pleased. The organisation of the engineering branch with continuous service in 1837 was the first of many changes to come.

The Direct-action Engine.—The earliest engines were of the side lever type, variations of the contemporary land beam engine adapted to driving the paddle wheels. The designs were cumbrous and heavy. The first change of importance was the fitting of a direct-action type engine in H.M.S. "Gorgon," of 320 nominal H.P., in 1837, the Seaward "Gorgon" type so-called which was the forerunner of a number of direct-action designs, so described because the crank centre was directly in line with the cylinder axis. In 1846 the "Gorgon" type engine for the packet "Caradoc," also designed by Seaward, was arranged with a crosshead guide in place of the parallel motion hitherto fitted in the "Gorgon" type. Thus appears the marine reciprocating engine sensibly in its modern form. The side lever engine was finally abandoned in the naval service in 1849, although it remained a favourite in the merchant service for many years afterwards. Some Atlantic liners were so fitted up till about 1860.

The "Driver," a sloop of 280 nominal H.P., which had a "Gorgon" engine, was the first steam vessel to circumnavigate the globe—1842—and she is of further interest as her boilers were fitted with mechanical stoking apparatus when she left England. They proved unreliable and were landed at the Cape.

Tubular Boilers.—Tubular boilers, retaining, of course, the old box form, were first fitted in H.M.S. "Penelope," a sailing frigate converted, lengthened, and engined in 1843, and this type replaced the flue boiler in the Navy in 1844. The "Penelope" was also fitted with surface condensers on the line developed and patented by Hall in 1834. They had already been fitted in H.M.S. "Megaera" in 1836.

The Screw.—The Admiralty had, since 1825, been seeking some alternative to paddle wheels, but without practical success, for they had, in common with contemporary professional opinion, dismissed the propeller as impracticable. But after preliminary trials commencing in October, 1843, which successfully determined the superiority of two short sections of helicoids as compared with two half-convolutions, the series of trials culminated in April, 1845, in the historic tug-of-war when, lashed stern to stern, the "Rattler" steamed ahead with the "Alecto" at a speed of 2½ knots. Generally, the series of trials, considered as a whole, was held to show that the screw was not inferior to the paddle wheel in fine weather, but some doubt continued as to whether it would prove equally efficient against wind and sea in heavy weather.

The fast-running engine was not then available, and, as in the case of most of the early naval screw ships, the "Rattler's" engine drove the propeller through four-to-one gearing, in the words of the contemporary text-books, "to increase the number of revolutions of the shaft, and thus enable the screw to make revolutions enough without giving undue velocity of the piston."

There was a general reluctance to apply the screw to merchant vessels before satisfactory results were reported in "Rattler." A notable exception, however, was the Atlantic liner "Great Britain," the first large iron ship, then under construction. In 1840, as a result of the trials in "Archimedes," the decision was made to change from the paddle wheel to the screw, with, as events proved, great success. The Admiralty experiments in "Rattler" were set on foot before the "Great Britain" was proved to be a success, but there seems little doubt that Brunel's courageous example was not without its influence.

The "Dwarf," formerly the "Mermaid," an iron steam vessel purchased by the Admiralty from Rennie in July, 1843, was actually the first screw vessel commissioned, and her special interest lies in the full-scale Admiralty experiments carried out at the suggestion of Thomas Lloyd, then Chief Engineer at Woolwich, and later the first Engineer-in-Chief, to ascertain the influence of underwater form on the propellers.

The results of the contemporary experience afloat in the use of the screw, and particularly the favourable reports of naval officers on the performance of "Rattler" on service, decided the Admiralty to adopt the use of the screw in 1845, when, as a result of the developments mooted in the French Navy, it was determined to increase considerably the steam navy. At the same time, it was decided to construct the engines so that every part of the machinery would be below the water line, and to arrange the screw and its fittings to be both readily unshipped and shipped in any weather, and thus to render the vessels perfect sailing ships as far as practicable, whenever the occasion for using steam ceased.

There was at the time of the adoption of the screw no type of engine available which would meet effectively the requirements of the screw under those conditions peculiar to the naval service, and all the prominent marine engineers of the country were therefore invited to submit designs, whilst being given quite a free hand, subject to the conditions before mentioned, and to a stipulated speed of revolution and diameter of the propeller. Tenders were accepted in this year for fifteen sets of screw engines for vessels of various dimensions, and distributed amongst eight prominent makers, of whom none was allotted more than two.

Developments between 1845 *and* 1860.—The decade following the introduction of the screw is particularly marked by the variety of engine designs which were developed to meet the new conditions of higher engine speed and accommodation below the water line, and, as may be expected at such times of transition when aspirations march ahead of practical fulfilment, the cases of removal of unsuitable engines were by no means rare. The use of mechanical gearing for screw ships was accepted perforce for a time, but the specifications early expressed a preference for a direct drive. By 1850 it was found possible to get designs avoiding the use of gearing, after which it was abandoned in new construction, thereby simplifying the machinery, reducing bulk and space, and obviating the noise which was objectionable in the early designs.

Boiler pressures, which had been increased generally to about 14 lb. per square inch by 1847, had reached 20 lb. per square inch by 1851, and remained generally at that figure for the next ten years. There were occasional designs with higher pressures, a particular exception being represented by the Crimean gunboats, of which over 200 were built for the war in 1854–55. Supply being urgently required, and with rapid production in view, the engines were made non-condensing, which, with the light design required, led to the boiler pressure being increased to 60 lb. per square inch. The boilers were cylindrical with straight-through tubes and were tested to 180 lb. per square inch. The engines ran at the then high speed of 220 r.p.m. The building of these gunboats affords an early example of what could be done by mass production, Penn having completed eighty sets of machinery in three months by duplicating patterns and distributing sub-contracts throughout the country.

The sloop "Malacca," of 200 nominal H.P., with machinery supplied by Penn in 1854, was also a high-pressure non-condensing design, and is of interest as being the first case in which boilers of cylindrical design with cylindrical furnaces were fitted.

Superheat was generally used in all designs, and this continued as standard practice until, with the general use of compound engines in 1870, pressures advanced generally to 60 lb. per square inch, when difficulties with engine packings, &c., led to its disuse. An early device for superheating, first suggested in 1827, consisted in the steam being arranged to pass through an annular space around the lower part of the funnel, but later designs were generally of tubular

* The Institution of Mechanical Engineers. The third Thomas Lowe Gray Lecture, Friday, January 3rd, 1930. Greatly abridged.

form fitted in the smoke-box. The use of a separate high-pressure boiler to provide steam for superheating the low-pressure engine steam was under consideration in 1848.

Until 1858, the demands for engine power in the Navy continued to be strictly moderate. At this time, all seagoing steamers for war or commerce were furnished with full sail equipment, and steam power was still regarded as auxiliary to sails. There appeared, indeed, no desire to make the fullest possible use of steam in the Navy, and although its application as an auxiliary proceeded, the period was one of indecision. The design of the "Warrior," our first ironclad, laid down in 1859, marked a distinct change, both as regards the outlook on the value of speed and the possibilities of getting higher speeds.

The change from wood to iron for warships was as much due to the influence of Scott Russell, backed by the technical success of the "Great Eastern," as to the envisaged shortage of suitable wood for shipbuilding should large demands arise. The use of iron at once rendered possible larger ship dimensions, and hence not only provided the space and weight for greater power, but ensured a proportionately greater return in the form of speed from the increased power than if it had been applied to smaller vessels.

The "Warrior" was of 9000 tons displacement, and made a speed of 14·4 knots on trial for an indicated horse-power of 5500. She was fitted with a single screw driven by a Penn two-cylinder trunk engine running at 54 r.p.m. The boilers were of the box, tubular form, designed for 20 lb. per square inch pressure, and were of iron throughout, except for the brass tubes. Ample sail power was provided. She could lower her funnel and hoist her propeller, and she proved as successful under sail as under steam.

Surface Condensers and Increase of Boiler Pressure.—The general opinion in 1860 was that pressures much in excess of 20 lb. per square inch were not advisable, and this limit appears, notwithstanding the availability of the surface condenser, then temporarily abandoned, to have been grounded upon the fears of priming and overheating of boilers due to the use of salt water feed. The naval experience with the 60 lb. gunboat boilers was far from satisfactory. Thus engine economy remained almost at a standstill. The growing military need of increased endurance in the Navy, however, together with the call for lighter machinery, led to sources of improved economy being exploited. The surface condenser was reintroduced first in "Octavia" and "Constance" in 1860, and was, in association with pressures varying from 25 lb. to 30 lb. per square inch and an increased ratio of expansion, generally specified from 1863 onward. For a few years the requirement was qualified by the condition that the condenser was also to be capable of being worked as a common jet condenser. The change in design was, like most other changes, not without its difficulties and troubles, which took the form in this case of corrosion in the boiler and tubes, threatening to shorten their lives appreciably. Numbers of cases are on record where boiler tubes lasted only six months.

Multi-stage Expansion Engines.—In 1859 Rankine and others had indicated on theoretical grounds the economies to be anticipated by higher pressures, but in the decade 1860–70 considerable controversy raged as to the practical advantages of the advance. The use of the compound engine marks the first considerable advance of economy since pressures of 20 lb. per square inch became general. Compound engines on the Woolf principle, and to the designs of Randolph Elder, were first used afloat in British ships, in association with a pressure of 30 lb. per square inch, by the Pacific Steam Navigation Company.

By 1872, although the compound engine was used considerably in the mercantile marine, its advantage was still an open question there, but general opinion inclined to favour it on grounds of the superior economy. It was definitely advocated for general use in the Royal Navy by a committee appointed in 1871 to report on the suitability of various designs of ships for their intended purposes.

After 1871 compound engines were generally specified and fitted in naval ships, in association with steam pressures up to 60 lb. per square inch, which led to a 5 to 10 per cent. increase in machinery weight, but to an increased fuel economy of at least 30 per cent. which on balance led to the desired end. In the case of H.M.S. "Briton," fitted with compound engines by Rennie in 1869, the fuel economy reached a very high order. With a boiler pressure of 60 lb. per square inch and engines running at 95 r.p.m., the indicated horse-power was 2000 and the fuel consumption on a six hours' trial was 1·98 lb. per I.H.P.-hour, while at 600 horse-power with a ratio of expansion of 15, the recorded consumption on a four hours' trial was 1·3 lb. per I.H.P.-hour. This is believed to be the greatest economy attained by any steam engine up to that date.

With the higher pressures the use of the trunk piston engine design had been abandoned for evident reasons. The advent of the twin-screw arrangement in 1860, and its general use beginning in 1868, removed the outstanding objection to the direct working connecting-rod type of engine, namely, the shortness of the rod in relation to the crank throw due to the short length available between the centre line of the shaft and the cylinders. The direct-acting engine accordingly became the standard naval type. It continued to be arranged horizontally, a somewhat expensive arrangement in respect to floor space, but necessary in the unarmoured vessels of the time to provide the required protection. The vertical engine was at this time fairly general in the mercantile marine, and came into the Navy in 1872 with the armoured ships, the need for underwater arrangement then expiring. The horizontal engine continued to be fitted in cruisers and smaller vessels until 1884.

After the establishment of the compound engine, pressures continued to increase steadily with improving manufacturing methods and the demands for better economy and reduced weight and space of machinery. The question of reduced weight came into particular prominence in 1875 when Kirk, of the firm of Elder, designed the vertical compound engines for H.M.S. "Nelson." These had, in place of the heavy cast iron bed-plates and columns generally used, a braced structure, comprising wrought iron columns and bed-plates, somewhat on the lines of the contemporary torpedo boat designs of Thornycroft. The condenser shells were of plate brass and the end doors were of wrought iron. By these means the main engine weight was reduced by about 10 per cent.

While the vertical engines permitted of higher piston speeds and led gradually to reduced engine weight on this account alone, it was in the direction of increased pressures that still further reductions were sought, and pressures rose by 1884 to 130 lb. per square inch. These pressures, however, brought the compound engine to the same condition in respect to temperature range as the simple engine which it had replaced. The first triple-expansion engines fitted in the Navy were in the "Sans Pareil" class in 1885, with a pressure of 135 lb. per square inch, and thereafter the type was employed for all new construction. The triple-expansion engines of the "Narcissus" class cruisers—1885—of 8500 I.H.P. were the last horizontal engines of any great size.

Twin Screws and Elimination of Sails.—Twin screws were first used in armoured gunboats and in the light-draught ironclad "Penelope" in 1865, but the extension of duplicate engines was not favoured, while sail power continued to be regarded as of great value, since the twin screws were prejudicial to good sailing, while the sails themselves provided a standby to the single engine. With the disuse of sails the adoption of twin screws became necessary to provide against the possibility of entire breakdown, and they were also of advantage in warships on account of the improved manœuvrability and improved watertight subdivision which they permitted. There was considerable controversy regarding their efficiency from the propulsive aspect, and they were not greatly employed in the mercantile marine until, with the increase of speed to 20 knots in Atlantic liners about 1886, their use came in for these high-power liners, where the desirability of dividing the large power became evident on grounds both of reliability and of manufacturing considerations.

Boilers.—The demands for lighter and less bulky machinery grew from 1874 with increasing urgency, in view of the need for higher ship speeds and more powerful armament and armour. While considerable success was achieved in this direction in the engines themselves, the attempts to increase the output of the boilers led to important boiler defects, such as leaky tubes and seams, cracks and distortion of furnaces.

Forced draught, first used by Hawthorn for large ships in 1881, was introduced for large naval ships in 1882. This, in combination with particular features in naval boiler designs which space and weight considerations demanded, such as the narrow tube spacing which restricting the circulation and common combustion chambers with relatively small heat-absorbing surfaces which led to high combustion chamber temperatures, reacted unfavourably on the tightness of the tubes, particularly under naval service conditions which call for sudden and wide variations of output.

Matters were improved somewhat in design subsequent to 1889 by the increased employment of separate combustion chambers. The tube leakage trouble was further mitigated to a certain extent by the use of tube ferrules which were introduced in 1892; but, nevertheless, the development of full power under forced draught in all the larger vessels fitted with return-tube boilers was generally attended with anxiety, and full power, even where attainable, could not be maintained for any length of time.

Doubts as to reliability of the boilers of the more modern warships were so prevalent that in 1892 a design committee was appointed to consider whether, in view of the reports from afloat indicating that the increased pressures were leading to difficulties and increased troubles from boilers, together with difficulty in maintaining the required fresh water for boilers, a reduction of pressure was considered desirable.

This committee, when reporting in 1892, emphasised the gain in fuel economy attending the use of higher pressures and triple-expansion engines. Considering also the improved smoothness of running and reduced vibration attending the three-crank triple-expansion designs, they recommended no reduction in pressure, but directed attention to various changes in practice and additions to existing equipment which promised, in the light of mercantile experience, to improve the durability. Briefly, they recommended an increase in heating surface, a reduction in the margin between natural and forced draught, reduction in grate length, separate combustion chambers in single-ended boilers, a general reconsideration of the tube spacing, and provision for circulating the water by external means. Increased distilling apparatus and the provision of grease extractors were also suggested.

With these changes it was considered that the boilers would be suitable for the naval service, but it may be inferred that the committee appreciated that the advances looming on the naval horizon could not be met by the cylindrical boiler, for their report concluded with the recommendation to fit two ships with tubulous boilers for experimental purposes without delay, and that a new cruiser should be arranged to receive tubulous boilers should the experiments be satisfactory.

Water-tube Boilers.—This marks the genesis of the use of the water-tube boiler for our large warships, and it will be convenient at this point to trace the sequence of later events.

An early example of the use of water-tube boilers afloat was s.s. "Thetis," built by Scott, of Greenock, in 1857, for experimental purposes. The machinery, which comprised compound engines and water-tube boilers with a working pressure of 120 lb. per square inch, was by Rowan, of Glasgow. Between 1859 and 1862 the desire to employ much higher steam pressures in the mercantile marine necessitated the use of a water-tube type of boiler and quite a number of vessels were fitted with designs by Rowan and by Howden. Some gave fairly long service, but they were all difficult to maintain, and in the long run were judged unsatisfactory and were sooner or later removed. The types of boiler were, in fact, ahead of the facilities available for providing pure feed water.

The water-tube boiler designed by Captain Cochrane—a development of the design installed by his father in the "Janus"—was fitted in 1865–70 in H.M.S. "Chanticleer," "Oberon," "Audacious," and "Penelope." The Perkins high-pressure type was also approved for H.M.S. "Pelican" in 1875, but was not completed owing to the withdrawal of the contractors. At this time other types of water-tube boilers were being successfully taken up by the French.

The first successful water-tube boilers in the Royal Navy were those fitted in the second-class torpedo boats by the Thames shipbuilders, commencing in 1885 by an installation by Thornycroft in torpedo boat No. "100." It was these craft and the torpedo-boat destroyers developed to counter them which pointed the way to higher ship speeds, and with the help of the water-tube boiler very substantial advances were made.

The "Speedy," a torpedo gunboat of 4500 H.P., was ordered in 1891 with Thornycroft boilers and carried out entirely satisfactory trials, including a series of long sea-going trials, during which the greatly improved flexibility of the machinery was amply demonstrated. The advantages realised in this vessel turned attention to the extended French experience with water-tube boilers, and investigation was made into the Belleville boiler, a type with which the most experience had been gained, especially in the long ocean-going voyages of the Messagerie mail steamers. It may be remarked here that the Belleville boiler is a very good example of persistent effort, having, I believe, been invented as far back as 1850.

As a result of the investigations made, it was decided in 1892 to replace for purposes of trial the unsatisfactory locomotive boilers in H.M.S. "Sharpshooter" by Belleville boilers, designed for a working pressure of 245 lb. per square inch. The trials were carried out in 1894, and in this year the decision was taken to fit the Belleville boiler in the cruisers "Powerful" and "Terrible," and meanwhile the use of the small tube boilers of the Thornycroft, Yarrow, and Normand type was being extended in the case of torpedo craft.

The "Powerful" was designed to attain a maximum power of 25,000 H.P. for short periods and a continuous sea-going power of 18,000 H.P. for as long a period as the coal lasted, a definite advance on previous practice. Experience shows that when later the boiler was understood by naval *personnel*, these design expectations were fulfilled, and for the first time since pressures began to rise appreciably our war vessels were able to develop their trial full power on service as and when required. The capacity to develop full power in the machinery was now only limited by the endurance of the *personnel*, and not, as hitherto, by the endurance of the material.

Her trials were carried out satisfactorily in 1896. Generally, the expectations of the design were realised, and the fuel consumption, namely, 2·06 lb. per I.H.P.-hour for all purposes at 20 per cent. of full power and 1·83 lb. at 72 per cent. of full power, compared favourably with the preceding designs. There was a substantial saving in weight of machinery, due, in part, to the use of higher pressures, but, taking the boilers only, the increase in the power-weight factor at maximum sea-going power was more than 20 per cent. above the earlier designs of large high-speed cruisers.

The Belleville boiler was adopted for new construction cruisers and battleships, but trials of other large tube types were arranged in smaller vessels, *e.g.*, the Niclausse boiler in "Seagull" and the Babcock

and Wilcox boiler in "Sheldrake." The last-named boiler had already been in use in the mercantile marine, the first important installation being in s.s. "Nero" in 1892. Similarly in the torpedo-boat destroyers use was made of all the suitable small tube types available for comparative trial.

The performance of the majority of the early Belleville-boilered ships on service fell far short of the promise given by the trials, and the mobility of these new naval units was, in fact, in some cases reduced to nil. Some of the trouble may be ascribed to the unfamiliarity of the naval *personnel* with the new conditions arising from the greatly increased steam pressures, no less than to material unsuited to meet adequately those conditions. The advance in pressure was, in fact, ahead of its time.

An Admiralty committee was appointed in September, 1900, to ascertain the relative advantages and disadvantages of the Belleville boiler for naval purposes, to investigate the causes of the defects and how far they were remediable, and to report on alternate types of water-tube boilers which might be suitable for trial.

The committee reported in May, 1902, after carrying out a great amount of investigation and full scale comparative trials. They considered no less than thirty-six different types of water-tube boiler. They reported in the sense that the advantages of water-tube boilers for naval purposes were so great, chiefly from a military point of view, that providing a satisfactory type be adopted, it would be more suitable for use in H.M. Navy than the cylindrical type; they considered the Belleville boiler had no such advantage over other types as to lead them to recommend it as the best type. They thought that four different types of large straight-tube boilers were sufficiently promising for use in large vessels in H.M. Navy, namely, the Babcock and Wilcox, the Niclausse, the Dürr, and the Yarrow large-tube boiler. Their advantages over the Belleville were "drowned" tubes, a definite water-level reading, and the fact that no surplus boiler pressure or delicate automatic feed regulators were required, and a fairly well-defined circulation was obtained. Some of these boilers were already on trial, and further trials were arranged with the Niclausse in "Fantôme," the Dürr in "Medusa," and the Yarrow large-tube boiler in "Medea."

The committee formed the opinion that no type of water-tube boiler then in use was, on general service, as economical as the cylindrical boiler, and, having also in view that a large proportion of the coal used was expended in harbour, they recommended that cylindrical boilers of sufficient power to work the auxiliary machinery and drive the ship at her ordinary cruising speed should be fitted until such time as a thoroughly satisfactory type of water-tube boiler was obtained. The boiler pressure was recommended to be 210 lb. per square inch.

The recommendations were accepted and no Belleville boilers were fitted after the designs then in course of construction were completed, one of the later designs to be so fitted being H.M. Yacht "Victoria and Albert," built in 1897, which continues in service to this day with her original boilers.

The succeeding designs of cruisers and battleships were provided for a time with dual boilers at the expense of increased machinery weight and space, until, from the various types of water-tube boilers suggested by the committee for trial and fitted in the naval programmes of 1902–4, the Babcock and Wilcox and Yarrow large-tube type boilers soon emerged as suitable types in respect of economy and durability for complete boiler installations in large vessels. Meantime, in the light cruisers and torpedo-boat destroyer classes, the three-drum, small-tube boilers of the Yarrow and the White-Forster types also proved their suitability for future needs, and were, after 1906, generally adopted in new construction.

Boiler pressures advanced to 300 lb. per square inch during the Belleville boiler stage, but were subsequently reduced to 210 lb. per square inch, as mentioned before, and shortly afterwards were increased again to 250 lb. per square inch, which remains the general practice to-day.

The cylindrical boilers in some of the ships fitted with the combination boiler system were provided with Howden's system of preheating.

Oil Fuel.—It is believed that the earliest successful experiments to burn oil fuel in connection with marine boilers were those carried out by Captain Selwyn at Woolwich Dockyard in 1867–70, using the steam-spraying system designed by Aydon. The fuel used was creosote. The many advantages of oil fuel for naval purposes were clearly appreciated, but special emphasis was laid on the necessity for a fuel heavier than water, which would sink clear of the vessel in the event of tanks being damaged in action, and it appears that the limited supplies of such fuels possessing this quality was the reason why the matter was allowed to lapse. The recent successful use of pulverised fuel brings to mind in this connection another instance of the resuscitation of a successful idea, in this case in a double sense. T. R. Crampton had also, according to a contemporary discussion on Captain Selwyn's experiments, burnt oil successfully at this time, but in view of the difficulties of supply he had devoted his attention to pulverised fuel. He had brought his devices to a fairly high degree of perfection, injecting the powdered fuel in quantities proportionately to the air stream in the belief that the ideas were original, only to find that his methods had been discussed some fifty years earlier. It appears that difficulties with the refractories for furnace linings led to the abandonment of Crampton's system.

So far as the Navy is concerned, the question of the use of oil fuel remained more or less in abeyance until 1898, when experimental work was commenced in earnest at Haslar. Ranging through methods of atomisation by steam and air, this culminated about 1902 in the development of devices for pressure spraying, otherwise called mechanical atomisation. This has remained in essence the system used by the Navy to this day. The effects of the characteristics of the various available fuels were fully studied, and the appliances necessary for the passage and mixing of the air for combustion and other purposes were simultaneously developed. By the time the Admiralty were satisfied that supplies of suitable fuel in the desired quantities would be forthcoming, the devices began to be applied to new construction, and subsequent to 1912 all new-construction battleships and cruisers were designed or modified to burn oil fuel exclusively, and at the present time the only important survivors of the coal-burning vessels in service are the battleships of the "Iron Duke" class.

The many advantages of oil fuel for the naval service are well known and need not be mentioned in detail. The military advantages of speedier fuelling and increased endurance, and the operating advantages of steadier steaming and improved flexibility are, however, deserving of emphasis, together with the favourable reaction on the design of the ship as a whole, and the number of men required to operate the machinery. In the design of torpedo-boat destroyers following the "Tribal" class, namely the "Beagle" class, the position as regards fuel supply was considered to entail a reversion, which proved temporary, to coal. The effect of the change is revealed by a comparison of the "Beagles" with the next following class, the "Acorns," both classes having been designed for the same speed and endurance. With a superior armament, the "Acorns" required 20 per cent. less displacement, they cost 16 per cent. less and attained on average a higher speed to the extent of 1½ knots. The effect on engine-room complements is even more marked. As an example, the "Lion" of 70,000 S.H.P., burning coal, required an engine-room complement of 608, whereas, in the oil-fired "Hood," of 144,000 I.H.P., the ship is operated with a complement of 306.

Turbines.—Sir Charles Parsons has stated that the marine application of turbines was mooted as early as 1884, but it was not seriously considered until 1892, when the economy of the turbo-generator ashore had proved it superior to the compound engine. Its application is one of the few important marine changes which were made without any setback and the initial success and the rapid extension of the system is undoubtedly attributable to the experience gained in its long and gradual development under proper conditions on shore, no less than to the soundness of the conceptions of the inventor and his thorough exploratory work in connection with the marine application.

The turbine was evidently particularly suited to the needs of fast vessels, and it was accordingly first fitted by Sir Charles Parsons in the "Turbinia," of 42 tons, in 1896, where a speed of 34½ knots was obtained.

The "Viper," of the same size as the contemporary 30-knot torpedo-boat destroyers, was ordered by the Admiralty in 1899, and while 31 knots had been guaranteed by the builders, the Parsons Marine Steam Turbine Company, she reached a speed of 33·38 knots under contract load conditions and 36·5 knots under light load. The installation was quite successful, but the trials revealed a low economy at cruising speed, and in 1901 the Parsons Company laid down as a speculation the "Velox," a torpedo-boat destroyer similar to the "Viper," but arranged with two reciprocating engines, each of 150 I.H.P. coupled to the low-pressure turbine shafts, through clutch couplings. These engines exhausted to the high-pressure turbines when in use at low speeds and were disconnected at speeds above 13 knots.

The cruiser "Amethyst" with Parsons turbines was ordered in 1902 and carried out comparative trials in due course with sister vessels equipped with reciprocating engines, which again showed the superior economy of the turbine at higher speeds, in this case 15 knots and above, the full speed being 23·6, against 22·3 for the sister vessels on the same fuel consumption.

As a result of these trials, although the experience of the turbine afloat was then very limited, the important decision was taken in 1905, after experimental investigations regarding such aspects as astern power capacity, manœuvrability, &c., to equip the battleship "Dreadnought" with turbines of 23,000 S.H.P., using a boiler pressure of 235 lb. per square inch. The order for the machinery was placed in June, 1905. A little later turbines were ordered for the "Invincible" class of battle-cruisers of 41,000 S.H.P. It may be mentioned, as an example of rapid production, that the "Dreadnought," notwithstanding her novelty as regards ship armament and engines, proceeded on trial within 366 days of being laid down.

From 1905 war vessels of all classes were equipped with turbines.

The capabilities of turbines of reasonable sizes to utilise steam at low pressure economically led to greater attention being given to the design of the marine surface condenser, which had remained for many years without appreciable change in type or proportions. In addition to alterations of form and proportions of the cooling surface, the ordered evacuation of air was provided for and special auxiliaries and accessories were developed for the purpose, with the result that the more exacting demands of the turbine were met by a much smaller cooling surface than had been usual in reciprocating practice. As an example, the "Agamemnon"—1904—had a cooling surface of 1·2 square feet per I.H.P., while the "Hercules"—1908—had a cooling surface of 0·8 square foot per S.H.P. The vacuum at full power was 25·4in. and 28·0in. respectively.

Geared Turbines.—Notwithstanding the success of the direct-acting turbines, it was realised from the first that the best performance of the propeller or of the turbine was not in general attained in the direct-drive installations, to such an extent, indeed, that, in the case of slow ships of low power, the application of turbines was quite out of the question. These considerations led to the design and development of suitable high-power reduction gearing by Sir Charles Parsons, and following trials and service in s.s. "Vespasian," so fitted in 1909, reduction gearing began to come into use in the mercantile marine, commencing in 1911 in the London and South-Western Railway steamers "Normannia" and "Hantonia" of 5000 S.H.P., built by Fairfield.

The geared turbine entailed a reversion to the use of the thrust block in its independent form. There appears little doubt that the availability of the Michell thrust bearing—a development based upon Osborne Reynolds's investigation into the problem of lubrication in 1886—facilitated the application of the geared turbine, if, indeed, it did not alone render its use practicable in installations of considerable power.

The first application in the naval service was in the torpedo-boat destroyers "Badger" and "Beaver," with machinery by Parsons, ordered in 1911, where the high-pressure turbines only were geared, the low-pressure turbines remaining directly connected to the propeller shafts. They were followed by the all-geared torpedo-boat destroyers "Leonidas" and "Lucifer," also by Parsons and ordered in 1912, which were completed by the outbreak of war in 1914. They went directly into war service, and served throughout the war. The cruisers "Champion" and "Calliope" of 40,000 S.H.P. were ordered in 1913. So the wheel again ran full circle, and after a lapse of sixty-four years, gearing reappeared in connection with the main engines of war vessels.

Submarines.—At the time of the introduction of the submarine in 1902 the employment of the petrol engine was necessary, the heavy-oil engine not being then sufficiently developed to meet the special needs. The shortcomings of petrol as fuel for this particular service were well appreciated, and in 1903 a heavy-oil engine design of 500 B.H.P., intended for use in one of the "A" class submarines, was ordered from Hornsby, a leading firm in the production of heavy-oil engines for shore purposes. The engine did not develop the desired power and was judged to be insufficiently advanced for service in a submarine. Vickers had been experimenting in the same direction, and in 1905 an order was placed with them for an engine of 500 B.H.P. with air injection. This engine was the subject of a good deal of experimental work, and in 1907 was sufficiently developed to warrant its fitting in submarine "A 13," and while the design still left a good deal to be desired in respect of reliability and durability—the compressors were particularly liable to defects—it marked a definite advance over the contemporary petrol engine.

The twin-screw "D" class of 1200 B.H.P., ordered in 1907, was first fitted with a new engine design by Vickers, based on the experience with the "A 13" engine, and this design, so far at least as the cylinder unit is concerned, was the basis of all subsequent engine designs up to and including the war period. The compressors, however, continued to prove a source of difficulty on service, and as a result of the work of Vickers and the submarine service, a system of solid injection was evolved with a view to eliminating this troublesome feature. The design thus modified, with various improvements suggested by experience on service, became the standard construction for most of the later submarine programmes, including those of the war period. Of a specially light construction, with fabricated steel columns and bearers, the engine developed 100 B.H.P. per cylinder at speeds of revolution up to 360 r.p.m. In the "E" class, designed in 1910, the power was increased to 1600, using an eight-cylinder design of the same standard construction as in the "D" class.

An attempt was made in 1912 in the "Nautilus" to increase considerably the engine power on the basis of experimental work carried out by Vickers. The design was intended to develop 3700 B.H.P. on two shafts, and although the vessel was never used as a submarine, the work of development was of considerable value in determining advanced problems of design. Similarly, in 1913 a steam-propelled submarine, the "Swordfish," of 7500 S.H.P., on two shafts, with geared turbines, was designed by Scott,

of Greenock, which, while also not used as a submarine, paved the way to the later successful developments in this direction.

Of the ninety-four submarines in construction prior to the war, seventy-eight were built by Vickers, the pioneers of this development in this country.

Condenser Tubes.—As may be inferred from my earlier remarks, leakage of condenser tubes appears to have been accepted as inevitable for a considerable time after the introduction of the surface condenser. The necessity, however, of providing for a pure feed supply with the increasing degree of forcing in naval boilers and the serious failures of condenser tubes in the Fleet in the preceding few years led in 1890 to the Admiralty policy of pressing for a higher standard from the manufacturers of condenser tubes which has remained in force to the present day. Till that date the manufacturers had been practically left to themselves. It must be recorded as an exception to the general rule that this interference was stoutly resisted by some of the tube makers, who, with a long record of successfully meeting commercial requirements by the use of time-honoured father-and-son processes, claimed that they knew better than the Admiralty what was wanted. It took many years to break down the opposition, but in the end I think they were convinced that the radical changes enforced from time to time were beneficial to both parties. The subject is of sufficient importance to warrant the relation of the measures taken. The leakage had been due to failure at the gland, or to splitting, or to perforation of the tube by corrosion or erosion. The last-named defect—perforation—was never entirely eliminated with the brass tube, but it was definitely reduced from year to year by such steps as the addition of tin to the alloy, purer constituents of the alloy and refinements in the manufacturing processes, coupled with the provision of cast iron water doors, steel protectors and increased care in design and operation. The first-named defects—gland leakage and splitting—were practically eliminated in the course of time by improvements in the accuracy of dimensions and in the manufacturing processes in association with design improvements in the condenser.

In 1890 the alloy was altered by adding 1 per cent. of tin, making the Admiralty mixture 70 per cent. copper, 29 per cent. zinc, and 1 per cent. tin. This was adopted as a result of the benefit proved to have been obtained by the same addition to naval brasses intended for exposure to sea water, suggested by Farquharson in 1874. Greater accuracy in dimensions was called for, and heating and jarring tests were introduced to provide a check against a tendency to split. The purity of copper was specified to be 99 per cent. In 1894 the packing test was instituted to ensure that the tubes were sufficiently hard to stand up to the packing when holding a 30 lb. per square inch water pressure test.

The trouble still continued to be serious, and between 1894 and 1900 provision was made for boring and turning the tubes before the final draws, this being introduced to ensure concentric tubes. In 1901 were introduced the following tests :—(*a*) All tubes to pass without splitting an end-flattening test to half the original diameter—subsequently made less stringent ; (*b*) sample tubes to stand heating to a dull red ; (*c*) sample tubes to be cut up for examination for surface defects ; and (*d*) all tubes to be drawn on a mandrel. The last stipulation was considered of great importance, as evidence showed that the failure of a great number of tubes on service was attributable to their having been drawn without a mandrel at the law draw. The flattening test also proved an effective means of detecting doubtful tubes.

In 1904 further measures were taken as a result of the continued complaints from afloat which, with the increasing use of the water-tube boiler, were to be regarded as even more serious than the earlier troubles, notwithstanding the great improvements made in the durability of the tubes. The principal changes were the increase of the water test pressure—formerly 300—to 700 lb. per square inch, sufficient metal to be turned and bored from the cast billets to remove all surface defects, and the tolerance on the external diameter to be 0·005in. As a result of further experience, a higher standard in the purity of components was called for, namely, copper 99·6 per cent. with a total impurity of the alloy not exceeding 0·025 per cent., together with a higher standard of accuracy of dimensions and concentricity and a limitation in the use of tube scrap to 20 per cent. With the addition of a provision for rigorous internal sighting of all tubes and an increase in the water pressure test to 1000 lb. per square inch, the tests described represent the standard Admiralty practice up to 1914.

War Period.—The further development of machinery was necessarily checked by the conditions imposed by war, but, nevertheless, the intensive experience gained on war service influenced design and hastened the application of some of the relatively untried innovations. Noticeably, the all-geared turbine, the use of which was extended in turn to most of the torpedo-boat destroyers constructed from 1916, to all cruisers, and finally to the battle-cruisers of the "Hood" class, of which only the "Hood" was completed. The use of separate cruising turbines, some of which have been of the geared type, was gradually dropped, alternative means being provided in the form of cruising stages in the main turbines to assure a proper standard of economy at low speeds.

The war period is particularly marked by the rapid production of monitors, submarines, torpedo-boat destroyers, and the host of auxiliary vessels, such as sloops, patrol boats, shallow-draught gunboats, minesweepers, trawlers, drifters, &c., which the needs of the war called into requisition. Their production affords a lasting example of the tremendous manufacturing capacity of the country and the adaptability of our marine engineering and allied manufacturers, many of whom had never before attempted the construction of oil engines, turbines, gearing and water-tube boilers. The auxiliary vessels were in general reciprocating engine designs with coal-fired boilers, which suited the needs of the case or the paramount consideration of rapid production. A reversion from Admiralty practice is to be noted in the numerous paddle minesweepers built during the war period, which were used as a result of the satisfactory performance and general suitability of paddle steamers taken up for this work during the early stages of the war. The aggregate horse-power of the propelling machinery produced during the war period for naval service exceeded 10 million.

It is, I think, a matter of common knowledge that the propelling designs during the war did all and more than was expected of them. While I am mindful that the success was in no small measure due to the efforts of the *personnel*, I am no less conscious of the debt the *personnel* owe to the patient work and enterprise in design which have led step by step, as I have attempted to describe, to the development of the machine by means of which the high degree of reliability and durability proved by the severe test of a protracted war, was alone attainable.

Conclusion.—My own service responsibilities have been mainly concerned with the operation and maintenance of the machinery afloat rather than with its design, and I shall not therefore be judged as being likely to have an undue bias toward the designers. I submit, however, that the foregoing record, wherein I have endeavoured, necessarily imperfectly from the very breadth of the subject, to co-ordinate the stages in the development of naval engineering material, reveals a high order of vision, courage, and enterprise on the part of those responsible for advising on engineering policy during the last few decades.

It may be said that they were not hampered by any commercial considerations which must operate inevitably against the general employment of new features until they are exhaustively tried out. That is true, but it must be remembered, on the other hand, that their trust was a weighty one, since upon the accuracy of their judgment depended the mobility and efficiency of the Fleet. Admittedly, too, the responsible authorities had afloat a body of men who could be relied upon to bring the designs to fruition if it was humanly possible to do so, but they were equally responsible for the initial engineering training and equipment which fitted the sea-going *personnel* to assume the heavy burdens imposed by the urgent need for progress in naval material.

The record brings out, too, and I hope no less prominently, the extent to which dependence has been placed on the efforts of the marine engineering designers and allied manufacturers throughout the country, to whose assistance the Navy has seldom looked in vain. I gladly acknowledge our obligations. I do not think it will be disputed that naval progress has reacted on commercial designs, and it is gratifying to feel that this continuous effort directed towards the development of weapons of war has not been without its influence toward the peaceful end of further economical ocean transport and free international intercourse.

From the naval aspect, the steam installation continues to give the best promise of meeting our needs for high-power surface vessels. The possibility of furthering the economy of the steam plant is by no means exhausted. The complications necessary to permit the exploitation of steam plants to the limits now realised on shore do not adapt themselves so readily to the marine case ; but, nevertheless, appreciable advances beyond the general standard are attainable. I may mention here the Canadian Pacific Railway Company liners of the 1928 "Duchess" class, where the oil fuel consumption of 0·64 per S.H.P.-hour for all purposes shows to what we may aspire. The work, too, in connection with materials suited to higher steam temperatures is not without some promise of still further advances with higher steam pressures up to the profitable limits for the marine case.

Of the alternative steam systems available for high-power ships, the mechanically geared turbine largely predominates, but the electrical transmission system is finding increasing use in the mercantile marine. On balance, the advantage of mechanical gearing for capital ships is somewhat narrow, but this advantage increases as the vessel becomes smaller and faster until in the limiting case of the torpedo-boat destroyers the electric transmission system is, as I think will be generally agreed, definitely impracticable. The general advantage resting in uniformity of machinery type appears likely therefore to continue to impose the choice of mechanical gearing for the steam drive in all our naval vessels.

For mercantile installations of relatively low power the steam reciprocating engine appears to have gained a new lease of life by the use of more highly superheated steam, by the adoption of the turbine to utilise to fuller advantage the lower end of the pressure scale, and by the use of drop valves in place of the time-honoured slide valve, the last named in some cases in association with compound engines.

The actual advantage of oil fuel over coal for steam generation in naval designs is considerably more than is suggested by a comparison of the calorific values alone. It need hardly be said, however, that the question of the use in suitable mercantile installations of powdered coal, which gives promise of affording a means of reducing running costs beside reducing to some extent this country's dependence on external supplies, is being watched with great interest. I think when the initial difficulties are solved, this system will find increasing use. The question of home-produced oil fuels is a matter of still closer interest to the Navy. As is well known, the problem of producing liquid fuels from coal is receiving very close attention from a great number of workers, and while it is early yet to predict whether and to what extent it will be possible to look to this source to meet naval needs, our experiments show at least that fuels suitable in respect of quality can be produced in this way.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

H. C. SIDDELEY AND CO., Ltd., ask us to announce that they have changed their address from York Mansion, Petty France, S.W. 1, to 50, Queen Anne's-gate, Westminster, S.W. 1. Telephone number, Victoria 3872 ; telegrams, "Cemicol, Sowest, London."

THE ENGINEERING AND LIGHTING EQUIPMENT COMPANY, Ltd., of Sphere Works of St. Albans, asks us to announce that it has purchased the assets of the Pinnacle Switchgear and Fuse Company, of Weybridge, and that the business of that company will henceforth be run in conjunction with the St. Albans works.

CAPROTTI VALVE GEARS, Ltd., asks us to announce that it has opened an office at 66, Victoria-street, S.W. 1, and that direct application to that office should be made for information concerning the Caprotti valve gears for locomotives, marine and stationary types of engines. The company informs us that it has secured the services of Mr. F. A. Pudney, late of Wm. Beardmore and Co., to take charge of technical matters concerning Caprotti gear development.

IN a note under this heading which appeared in our issue of January 3rd it was stated that the American Car and Foundry Export Company, of New York, had asked us to announce that it had opened a London office at 25, Victoria-street, S.W. 1, and that the agency carried on by Messrs. Davis and Lloyd, of 26, Victoria-street, S.W. 1, ceased on December 31st, 1929. The words "American Car and Foundry Export Company, of New York," should have read "American Locomotive Sales Corporation, of New York."

ERRATUM.—For A. Cockburn and Co., of Glasgow, in the third column of page 2 of our last issue (Reducing Valve for the L.N.E.R. High-pressure Locomotive) read Cockburns Ltd., Glasgow.

PRESENTATION TO LONG SERVICE EMPLOYEES.—An interesting ceremony was recently performed at Rochester, when gold watches were presented by the chairman of Aveling and Porter, Ltd., to sixteen men who had been in the firm's service for fifty years or more.

THE SALERMO PROCESS OF LOW-TEMPERATURE DISTILLATION. —We have received from Salermo Ltd. a copy of a booklet dealing with the Salermo process of coal distillation, described in THE ENGINEER, October 4th, 1929. This booklet contains much new matter relating to the nature and use of the products obtained when coal is subjected to low-temperature treatment, and describes possible future developments in this field. The new Salermo retort which is now being introduced into industry is described.

A TURBINE BROCHURE.—A handsomely produced brochure on the Richardsons, Westgarth-Brown Boveri turbine has just been issued by Richardsons, Westgarth and Co., Ltd., Hartlepool. Whilst it is devoted to the special type of turbine made by the firm named, it contains general notes on turbine design and many interesting sectional drawings of complete machines and details. Engineering students in search of some of the more practical aspects of turbine engineering than are generally given in text-books should find it useful to them, whilst it will appeal to all who want particulars of turbine equipments.

A NEW GALVANISING WORKS.—On New Year's Day, Madam the Mayor of Hereford performed the opening ceremony in connection with a new industry in that city. At Messrs. Painter's works there is being fabricated a considerable amount of steel work for electric transmission towers for the South-East England "grid" scheme, and closely adjacent to those works Baldwins Ltd. have put up a plant for galvanising the pieces in question. The plant comprises several pickling tanks and a couple of coke-fired galvanising baths which are easily capable of dealing with the longest members built into a standard transmission tower. It is not necessary to enlarge here on the routine and technique of the works, as such processes are familiar to our readers. We may say that subsequent to the opening ceremony a luncheon was held in the city, at which there was a general expression of opinion that Hereford was to be congratulated on the establishment of a new industry.

"A.C.E.C."—To celebrate the twenty-fifth anniversary of its existence under its present name, the Ateliers de Construction Electrique de Charleroi recently produced a special number of its quarterly bulletin, in which the progress of development of the company's activities are described and illustrated. The A.C.E.C. sprang from la Société Electricité et Hydraulique, which was founded in 1886, and played an important part in the electrical development of Belgium. It was, however, unable to face foreign competition, principally that of Germany, and by 1904 was on the point of dissolution. It was then that Monsieur Empain, whose death occurred recently, undertook, at the request of King Leopold II., an attempt to reconstitute the electrical industry of Belgium. He took over the works at Charleroi, and by energetic management and by securing the placing of orders from railway enterprises, he firmly established the new company, extended the Charleroi works, acquired others, and enabled the A.C.E.C. to supply all sorts and kinds of electrical engineering equipment, including cables. The bulletin, which is printed in French, is admirably got up, and photographs of the works and their products are excellently reproduced.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Birmingham Quarterly Meeting.

THE first quarterly meeting of the Midland iron trade held in Birmingham to-day—Thursday—proved uneventful. It was largely attended by representatives from all parts of the country, but the volume of business transacted was not what would normally be expected at a gathering of this description. A hopeful tone prevailed throughout, but the unsettled state of industry in general is against the placing of long-date contracts, and the bulk of orders given out were on account of current or near requirements. Inquiries are numerous, and give promise of some good business in the near future. Consumers lacked sufficient confidence, however, to enter into anything in the nature of speculative deals. Conditions in the iron and steel and engineering industries are much as set out in my letter last week, the past seven days' trading and the quarterly meeting combined not having, at any rate up to the time of writing, done anything materially to alter the situation.

Finished Iron.

There was no spectacular buying of finished iron at to-day's quarterly meeting, but orders for limited supplies, chiefly of marked bars, were given out. It is rather surprising how steadily business has come to the Staffordshire marked bar makers of late. Week by week has brought its quota of orders and though commitments have not at any time recently been heavy, steady and regular output has been maintained. Ironmasters this week were quite prepared for a continuance of this state of affairs, and they were not disappointed. Values of marked bars were unchanged at £12 10s. per ton, nor was there any alteration in quotations for Crown bars, which vary between £10 and £10 7s. 6d. Several makers who have expressed every desire to attain a higher standard of prices and who have been asking £10 7s. 6d. are said to have been willing this week to make concessions. Though selling prices are poor in the light of increased production costs, keen competition, locally and from other iron-making districts alike, gives makers little chance of maintaining a firm stand. Business in nut and bolt and fencing bars shows little change. Consumers continue to purchase supplies from abroad at relative low prices, and local ironmasters are powerless to compete. The Black Country consuming industries are moderately well employed, and considerable tonnages of Belgian material are regularly coming into the district. Wrought iron gas tube strip is an active market, with prices firm at £11 2s. 6d. per ton. A fair volume of activity should be maintained at the ironworks during the current quarter.

Pig Iron.

The possibility of a higher range of prices for raw iron being declared by the Pig Iron Producers' Association at its meeting this month urged users to activity this week. Many sought to renew or enter into fresh contracts at current rates, while others endeavoured to build up some reserve of material. Blast-furnacemen were not at all anxious to do business, but, nevertheless, a large tonnage of material was bespoken. Some of the Derbyshire furnaces which prior to the holidays were behind with their deliveries have now righted the position, but others have still some leeway to make up. Furnacemen generally are in a strong position, having sufficient contracts on their books to absorb the greater portion, if not the whole, of their output of foundry iron over the first three months of the year. There is more forge iron on offer than the market can absorb, a condition of things attributable, to a great extent, to the unsatisfactory position of finished iron makers in the Black Country. The foundries in this district are moderately well employed, and have good prospects, so that the demand for foundry grade iron may be expected to be well sustained. It was reported this week that in some instances premiums have been paid for material urgently needed, but the general rule is for business to be done at the minimum figures laid down by the Association. At the time of writing these remain unaltered at:—Northamptonshire: Forge, £3 11s.; No. 1 foundry, £3 18s.; No. 2, £3 17s.; No. 3, £3 15s.; No. 4, £3 14s. Derbyshire: Forge, £3 14s. 6d.; No. 1 foundry, £4 1s. 6d.; No. 2, £4 0s. 6d.; No. 3, £3 18s. 6d.; No. 4, £3 17s. 6d.—all per ton delivered at Black Country stations. Smelters complain of being unable to get their full quota of coke against contracts. The fuel market continues very firm, quotations for blast-furnace coke being maintained at 18s. 6d. per ton at ovens.

Steel.

Business in the steel department was quiet this week. Purchases of heavy steel made in anticipation of the price advance which occurred just before the holidays have satisfied consumers' requirements for the time being, and they now await the trade expansion which will enable them to use up the material now booked and justify them making fresh purchases. Constructional engineers have received a few inquiries this week, but in nearly every case the tonnage involved is small, and makers hope that the coming months will bring some really heavy contracts for bridge building and similar work, involving thousands of tons of steel. The quarterly meeting did not produce any great volume of business, but steelmasters on 'Change spoke optimistically of the future. Steel values are unchanged. Angles are quoted £8 7s. 6d.; tees, £9 7s. 6d.; joists, £8 10s.; ship, bridge and tank plates, £8 17s. 6d.—all, of course, subject to rebate. Boiler plates are priced at £9 12s. 6d., and Staffordshire hoops at £10. There was a moderate amount of activity in the half-products branch. Small bars were quoted £8 2s. 6d. upwards, and mild steel billets £6 5s. Some offers of supplies of billets at £6 2s. 6d. are reported, but this is not the generally accepted price. Sheet bars command about £6. The steps taken to regulate selling prices of foreign semis have safeguarded the market against disintegration. Billets at about £5 12s. for 2in. and £5 9s. for 3in. are not so unstable as they were at the end of November, but business is quiet. Black Country works are taking deliveries of foreign strip, bars, and billets.

Galvanised Sheets.

The turn of the year has brought no improvement in the local galvanised sheet industry. The much-needed revival in overseas demand shows no evidence of its approach, while home requirements are small and irregular. Most of the mills are so badly in want of orders that they are reported to be willing to accept £12 5s. per ton for 24-gauge corrugated sheets, though generally they quote £12 7s. 6d. Such stagnation as is now being experienced in the industry has not been known for a considerable time, and rollers express concern as to the immediate future. Black sheets for the automobile engineers are in steady and increasing request, and in this department there is no change in prices.

Steel Scrap.

Dull conditions continue to characterise the steel scrap market. Many South Wales steel works have suspended deliveries of scrap as they are overstocked. Birmingham merchants who quote £3 7s. 6d. for heavy steel scrap and £2 17s. 6d. for steel turnings, in some cases on 'Change to-day offered to accept slightly lower figures, but users refused to buy. Increased activity at the Welsh works is said to be absolutely necessary before any substantial improvement in the scrap market is possible.

Coventry Engineering.

The engineering industries in Coventry opened the year 1930 with fair prospects. Motor engineers report very keen competition, but consider further progress during the year almost a certainty, provided the measure of protection afforded by the McKenna Duties is not withdrawn. The whole outlook for Coventry would be changed were anything to transpire to upset the city's premier industry upon which so many others depend. Automobile engineers have in many cases their output over the first three months fully booked, orders to date showing an increase over the corresponding period last year. Momentum is increasing gradually in the light car branch and the heavy vehicles section is well employed and has hopeful prospects. Efforts are being made in all departments of the industry to extend the overseas trade, upon which so much will depend in the future, if continued progress is to be made.

Ring Gas Main.

A scheme for the provision of a high-pressure ring gas main, with feeder mains round the city, at an estimated cost of £109,895, is just now before the Coventry City Council. The ring main suggested by the Gas Committee of the Council would run from Foleshill gasworks around the city, which would, it is stated, result in a constant pressure being always maintained throughout the area of supply, and would enable the Kenilworth gasworks to be discontinued for manufacturing, besides presenting other advantages. The mains would be laid along the lines of new "town-planning" roads, and the total length would be a little over 18¼ miles.

Staffordshire Coalowners' Opposition to Mines Bill.

South Staffordshire and East Worcestershire coalowners, at a meeting on Monday, outlined the reasons for their opposition to the Coal Mines Bill, and in particular the principle of output regulation, and emphasised the necessity for having this district exempt from the regulation of output clause in the Bill. The statement of the area Coalmasters' Association pointed out that the unique physical conditions of the South Staffordshire coalfield did not lend themselves to part-time working, which would increase the dangers both to the miners and to the collieries; that the output of the district was being steadily reduced, owing to the flooding and working out of many of the mines; that the number of thick-seam coal mines would be reduced under output regulation; and that the demand from the immediate district was greater than the output of coal in the district. Approximately 6d. per ton would be added to the cost of production, the statement disclosed, if pits "played" even one day per week, and that in conjunction with other factors would necessitate an increase in price to be charged to the consumer of 9d. per ton. In the event of miners' wages being the same for 7½ hours as for 8 hours' work, the increased cost would be 1s. 3d. per ton and domestic coal would be advanced several shillings per ton. If, owing to output restriction, mines could not be worked owing to the heavy cost of pumping water, which had to go on whether the pit was working or not, a large quantity of coal would be lost. The effect on selling prices would be considerable, as it would be necessary for the district's requirements, at present supplied from nearby pits, to be met from other districts, with a greatly increased transport charge. As the industries of South Staffordshire had been built up on cheap coal, the enforced closing of pits in the district would have a detrimental effect on the cost of production of consuming industries, and might even have the effect of putting some of the industries depending on cheap fuel out of business completely. The largest users of coal in the district were the local steel works, and it was unthinkable that they might have to buy some of their requirements at a much higher cost from pits other than their own. It was stated at the meeting that the annual output of coal in the South Staffordshire and East Worcestershire area was about 1¼ million tons.

Cannock Chase Coal Profits.

There was an average profit of 1s. 2·11d. per ton on all coal produced in the Cannock Chase and Pelsall coalfield in November. The figures for the previous ten months were:—January, 2s. 2·44d. profit; February, 3s. 2·76d. profit; March, 2s. 8·67d. profit; April, 9¼d. loss; May, 1s. 1·18d. loss; June, 1s. 4·47d. loss; July, 6¼d. loss; August, 66 per cent. of a penny loss; September, 1s. 1·20d. profit; October, 4d. profit. The owners' accumulated deficiency is now £1,139,870, against £1,122,412 a month ago and £900,638 twelve months ago. The wages of the miners during January will continue at the minimum rate of 42 per cent. on the 1911 basis, giving stallmen a minimum wage of 9s. 4d. a shift, loaders 8s. 4d., and able-bodied surface workers 6s. 8d. The owners' real ability to pay, however, is only 31·60 per cent. With the exception of three months, minimum rates have prevailed during the past year. Increases were recorded in April 9s. 7d., May 9s. 11d., and June 9s. 6d.

Warwickshire Coal Matters.

As a result of the ascertainment in the Warwickshire coalfield for the month of November, wages of miners in the area were increased this month by 2 per cent., bringing the percentage payable on basis rates to 47. The output of coal in Warwickshire in November was slightly lower than in October, the figures being October 315,000 tons, November 297,000 tons, but 17,000 tons higher than in November, 1928. In November the net profits were 2s. 4d. a ton, the same as in October and 6d. a ton higher than October, 1928.

Belgian Metal for Birmingham.

Uniform booking arrangements which will facilitate the shipment of iron, &c., from Antwerp and Ghent, destined for the Birmingham district, are to be put into immediate operation by the various shipping companies acting in agreement as a result of a conference in London on the 3rd inst. Traffic booked by any of the lines included in the scheme can now be transferred under a booking contract to any of the operating companies on a *pro rata* basis. These arrangements will result in greater regularity of sailings, and delays in shipment will be prevented.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Through a Dark Phase.

IN an attempt to diagnose the reason why, to use his own expression, the engineering industry of this country is virtually living from hand to mouth, begging for orders, while the engineering industries abroad are prosperous and developing new lines of business, Mr. George E. Windeler, President of the North-Western Section of the Junior Institution of Engineers, speaking in Manchester on Monday, said that part of the cause of the troubles of the engineering industry, which is passing through a dark phase of its history, appears to be within and not without. Engineers in other countries besides Great Britain have to contend with serious difficulties in the way of heavy taxation, Government interference, keen competition and reduced purchasing power, yet the condition of their industries is less unsatisfactory than ours. Mr. Windeler asked the men who held important executive positions in engineering whether they were doing everything they could by co-operation and initiative to produce ideas which would cheapen design, improve output, reduce the cost of production, and generally help to bring about a better state of affairs. In a nutshell, his view is that, whilst never in its history has this country had so great a wealth of trained ability to deal with, there was among engineers a notable lack of the proper spirit of co-operation.

American Engineers and Liverpool.

Mr. Matthew Anderson, general manager of the Liverpool Organisation, who has recently returned from a visit to the United States, which was undertaken with the object of interesting American financial and industrial interests in the possibilities of Liverpool and its environs as a centre for new enterprises, appears to have been not unsuccessful. He informed a meeting in Liverpool on Monday that among other American concerns which might establish branch factories in Liverpool were a general engineering firm, a firm manufacturing machine tools, two tire manufacturing companies, and a firm engaged in the manufacture of wireless equipment. Mr. F. J. Marquis, chairman of the Organisation, suggested that the Government, instead of spending money on relief works, should see if by large-scale advertising it could not stimulate British industry so as to enable it to absorb more labour.

£600,000 Reservoir for Rochdale.

A Bill which Rochdale Corporation is to present to Parliament, seeking powers to construct a new reservoir at an estimated cost of £600,000, has just been approved by a meeting of ratepayers.

Obituary.

Mr. Thomas Whyman, managing director of Whyman's Foundry Company, Ltd., Warrington, died on Tuesday of this week, at the age of seventy-one. Mr. Whyman, who was previously associated with the Falkirk Iron Company, purchased in 1901 the works of the Hope Foundry Company, Warrington, and began the manufacture of rain-water castings, a business which was very successful and eventually embraced, besides iron, castings of aluminium, brass and other materials.

Non-ferrous Metals.

Copper alone of the non-ferrous metals during the past week has displayed any marked strength, although on balance spelter also is dearer to the extent of a shilling or two. The movements of all metals have been on a freer scale than in either of the two preceding weeks, but in no instance can the demand be described as active. Buying interest in refined copper has been on moderate lines, and values have been maintained, whilst in the case of the standard metal prices are higher by £3 or £4 a ton, which is about the best recorded since mid-October. The demand for tin is still below normal and with both domestic stocks and visible supply figures higher the statistical position during the past week has been distinctly bearish in

character. The result has been a decline in quotations, which, at the moment of writing, is equivalent to about £2 a ton. Current offers of lead seem to be more than sufficient to meet the demand, and there has been some reaction after the advance registered a week ago, the net loss since last report being in the neighbourhood of 5s. a ton. Spelter values are still weak and are hovering either side of £20. The outlook in this section continues to be the reverse of promising, and in view of the heavy supplies an improvement to the extent of even 2s. 6d. a ton is somewhat surprising.

Iron and Steel.

Except for the influence of prolonged stocktaking operations in some cases conditions in the pig iron section of the Lancashire markets have returned pretty well back to normal. Midland counties makers offering here appear to be fairly well sold, and there is no undue pressure to sell, some producers during the past week having reverted to premium quotations. Bookings over the current quarter continue to be reported and a steady flow of specifications is being received. This section of the market fully retains its firmness, with Derbyshire and Staffordshire No. 3 both quoted at 77s. per ton, Scottish at about 95s., and West Coast hematite at 92s., all delivered equal to Manchester. With regard to manufactured iron the demand for this is very moderate and the outlook not too hopeful. Prices, however, are maintained, with Lancashire Crown quality bars at £10 15s. per ton and seconds at £9 15s. Conditions in respect of heavy steel are rather mixed and the market appears still to some extent to be subject to seasonal influences. Some rollers during the past week have experienced a rather better movement of boiler plates to locomotive engineers in the area, and there is also a steady demand for bright-drawing bars. Here and there constructional firms are taking better quantities, but this does not by any means apply to all, a number being short of work. Large and small bars, including the re-rolled varieties, are in limited request on this market, and the demand for general plates also is slow. Quotations are firm all round, however, with angles at £8 7s. 6d., joists at £8 10s., large bars at £9 7s. 6d., boiler plates at about £10, general plates at £8 17s. 6d., and small re-rolled bars at from £8 5s. to £8 7s. 6d., according to quantity.

BARROW-IN-FURNESS.

Hematite.

The New Year starts under fairly good conditions, and there are signs that the hematite pig iron market is going to be brisk. Makers are booked up in many cases for several months and there is every likelihood of buyers covering themselves for a longer period, and it is more than likely that they will place contracts to meet their requirements up to six months ahead. The home trade promises to be very steady and the continental demand, mostly for iron of stated analysis, is likely to be more than maintained. American business is also promising. The pig iron trade is steady, with a regular local demand and a fair business with ironmakers outside the district. The steel trade is on the whole slightly better and the outlook at Workington is brighter. Rail contracts held will take about three months to complete, and it is reported that the United Steel Company is in future to roll all its rails at Workington. If this is true it is good news for Cumberland, for the improvement in this department will be reflected on the iron production. At Barrow the rail mills are at work, but it is not known how far the present contracts will take them. Hoops are in good demand, mostly on overseas account.

Shipbuilding.

Vickers-Armstrongs, Ltd., have completed at the Barrow Shipyard H.M.S. "Resource," and the vessel left Barrow for Portsmouth on Tuesday afternoon. She is a repair ship and will be attached to the Mediterranean fleet. She is 500ft. long, 83ft. in beam and 49ft. in depth, and is of 14,500 tons displacement. Her geared turbines, working twin screws, develop 7500 S.H.P. The vessel is fitted with workshops and plant capable of dealing with repairs at sea and independently of the shore base.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade Conditions.

THERE is not much change to report in the state of the various branches of the steel trade, and the summary which I gave last week of the present position and prospects for the New Year holds good. Speaking generally, it may be said that basic production remains at a good level, while the acid side is disappointing. There is but small demand for ordinary steel manufactures—those which are known as "bread and butter lines"—but the special departments have a large amount of work in hand in connection with stainless steel, cold-wrought steel, automobile and aircraft parts, and other products. The departments producing axles, tires and springs for the railways would welcome a great deal more work. Although the requirements of the home railway companies have shown some increase of late, they are still being kept down to very economical proportions, and the amount of work coming from overseas is only moderate.

Forgings for Shipbuilders.

A department that has done well lately and that promises well is that of heavy steel forgings, including hollow rolled boiler drums and also marine shafting. In the latter department, the English Steel Corporation has received a good number of orders from British shipbuilders during the past year, a good deal of the trade having been won from Germany and Belgium. For many years past a large tonnage of forgings for shipping construction has been imported at lower rates than the British steel makers could quote, but the English Steel Corporation has put down new plant in an endeavour to produce shafting at prices which would successfully compete with the continental figure. The British material is superior to the foreign, and there is confidence that the trade will show an expansion during the present year.

Cutlery and Plate.

There has not yet been a full resumption of work in the cutlery and plate trades, as firms usually suspend business for a week or two in order to carry out renovation and repair of factories. There is, however, activity in some cases, where orders requiring immediate execution are on hand. The demand for stainless steel table cutlery continues large, and while the greater part of it relates to goods of the cheaper grades there is also a very useful call for the higher qualities. Firms making best pen and pocket cutlery have a considerable amount of business on hand. The scissors trade, which has shown much improvement during the last few months, continues brisk, some houses being exceptionally busy in this branch. The output of safety razor blades has declined somewhat of late, but is still on a large scale. The call for articles of cutlery and plate for coupon distribution is well maintained.

Colliery Development.

Work is now in progress in connection with the development of Upton Colliery, South Elmsall, in the Doncaster district, after a suspension of about two years. The No. 1 shaft was sunk before work was stopped, and coal from it is now being sold at Upton. Very soon the No. 2 shaft will be down to the coal level. It was found that, during the suspension of operations, water had accumulated in this shaft to a depth of 280 yards. The shaft has now been pumped clear, and sinking has been resumed. Only about 40 yards remain to be sunk before the Barnsley seam is reached, and it is expected that this work will be finished in five or six weeks. A roadway will then be made to connect the two shafts, after which a constantly increasing number of men will be employed. Steps are now being taken to complete the surface plant and siding accommodation. Temporary cages are to replace the old hoppits used for sinking, and these will enable a large quantity of coal to be drawn to the surface at once.

Orders for Rolling Stock.

Among a number of contracts for railway equipment recently announced is one for thirty steel passenger brake vans, placed by the London, Midland and Scottish Railway Company, with the Metropolitan-Cammell Carriage, Wagon and Finance Company.

Greek Irrigation Scheme.

Very interesting are the fuller details which are now available concerning the great work of land reclamation and irrigation in Greece, for which the Sheffield firm of Henry Boot and Sons, Ltd., has successfully tendered. The matter is not yet absolutely settled, as the contract has to be ratified by the Greek Chamber of Deputies and the Senate, but it is expected that these steps will be completed by the end of the present month, after which the contract will immediately become operative. It will be the greatest contract of its kind ever entered into. Its scope and object are defined as being "the elaboration of general preliminary studies and complete final studies for the construction of reclamation, anti-flood, river and stream control, irrigation and hydro-electric works, and also the eventual construction of these works." Owing to the fact that a great part of the area to be dealt with has never been surveyed before, it is impossible to forecast the actual expenditure, but it will be at least six million sterling.

Work in Seven Areas.

Seven different areas are concerned in the works, namely, Thessaly and the adjoining watersheds and lakes; the watershed of the rivers Louros and Arachthos, in Epirus; the watershed of the river Acheron and the Margariti marshes, in Epirus; the watershed of the lakes of Jannina and Lapsista, in Epirus; the plain of Platania and Kalimbari, in Crete; the watershed of lake Kurna, in Crete; and the plain of Messara, in Crete. The total area extends to thousands of square miles. The contract provides that the contractor shall, within two years, submit a separate technical preliminary study for each of the seven areas, with corresponding financial reports showing, on the basis of the cost of construction and of the benefit to be expected therefrom, the productiveness or not of the work, and the advantage of the construction of the whole or part of it. Final studies are afterwards to be submitted separately for each area, and are to be completed within ten months of the communication of approval of the last preliminary study. The scope of the studies may be summed up in the statement that they embrace a topographical survey of the area, an engineering survey, and complete plans and detailed estimates of the proposed works. Any of the works which the Government decides to have constructed, within ten years of the approval of the last preliminary study, must be placed with Messrs. Boot for execution. Messrs. Boot will employ their own engineers to carry out the survey. Under the terms of the contract, the actual workmen will be Greeks, but the carrying out of the undertaking will provide a considerable amount of work for this country in the provision of diggers, dredgers, and similar heavy plant.

Testing of Wire Ropes.

An interesting piece of research work recently carried out in the Applied Science Department of the University of Sheffield has been concerned with the development of an electromagnetic apparatus for the testing of wire ropes. The work has been carried out in co-operation with the Carlton Collieries' Association and the British Thomson-Houston Company. The main purpose for which the apparatus has been developed is to detect internal flaws in colliery winding ropes, although its application is not restricted to that purpose. It can be used for testing wire ropes operating in any service, such as mooring ropes for airships, wire ropes for cable tramways, and like purposes. In accordance with the regulations laid down by the Mines Act, winding ropes in collieries must be taken out of service after 3½ years. This is a safety precaution to prevent accidents due to internal flaws which it has hitherto been impossible to detect by non-destructive methods. No doubt many ropes are thus compulsorily put out of service while they are yet capable of considerable further life, and as such ropes may cost anything up to £1000 or more each, the scope for a reliable electromagnetic testing apparatus for detecting whether a rope is sound or not is a wide one. A complete electromagnetic rope-testing equipment has been installed at the Hatfield Main Colliery, Doncaster.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Outlook.

THE New Year has opened with a confident belief in Northern industrial circles that further progress will be made in the path of trade recovery. It would, of course, be idle to suggest that there is any short cut to more prosperous conditions, especially in the coal and iron and steel industries. In fact, the goal is still far distant, and many obstacles have to be surmounted. But at least the mists and shadows are lifting, and it is possible to see ahead more clearly. Very encouraging is the continued expansion in steel production, in spite of the severe handicap under which manufacturers in this country have to contend in competing against foreign rivals. A plate mill is to be started next week at the Stockton works of the South Durham Steel and Iron Company, Ltd. After opening out for a few weeks last year this mill had to close down in November, owing to a falling off in orders. At present, however, while there is no intention of further developments on these lines, it is safe to assume that the mill will be kept going for some considerable time.

Large Order for Steel.

Continuous employment for three months is assured for the steel sleeper producing plant of Dorman, Long and Co., Ltd., Middlesbrough, by an order received from the Crown Agents for the Colonies. The sleepers, 9000 tons of which have been ordered, are required for the railways of Uganda, Kenya and Tanganyika. The sleepers will be manufactured at the South Bank works of the firm, at which the plant is capable of producing 600 tons of sleepers per week.

More Shipbuilding Orders.

The shipbuilding industry on the North-East Coast has ushered in the New Year with a considerable addition to the substantial amount of work already in hand, and the reopening of a yard which has been closed for many years past. The Old North Shore Shipyard at Stockton was acquired by Smith's Dock Company, Ltd., in the autumn of last year, and the berths have since been reconditioned and new machinery installed. The firm acquired the North Shore Yard as an overflow establishment, and it is so busy at South Bank that the keels of two vessels are being laid at the Stockton establishment. Four new orders for ships are announced. Sir W. G. Armstrong, Whitworth and Co. have secured orders from Scandinavian owners for two motor tank vessels to be built at their Walker shipyard. One is of 11,500 tons and the other 8800 tons. The propelling machinery of both will be of the Armstrong-Sulzer type of engine, to be constructed at the firm's Scotswood works. Two large cargo vessels for R. Ropner and Co., of West Hartlepool, are to be built by William Gray and Co., of Sunderland and West Hartlepool. One or both of these vessels, each about 9000 tons, will be laid down at Messrs. Gray's Wear yard. Triple-expansion engines for the vessels will be constructed at the firm's Central Engineering Works, West Hartlepool. Several inquiries by shipowners are circulating on the North-East Coast, but price difficulties are hampering negotiations. In several cases the long-term credit which owners are holding out for will probably mean that the orders will go elsewhere. The wage increases for shipyard workers, which came into operation this week, are also having some effect upon the negotiations.

Cleveland Iron Trade.

As yet there is no real tendency towards business expansion in the Cleveland iron trade. The prolongation of the New Year holidays in Scotland is holding up business in that direction, but the prospects there are more hopeful from the Cleveland ironmasters' point of view, as Midlands iron prices are very firm and a rise at the end of the month is not improbable. Export business is very slow and home consumers are not yet placing orders for current needs in any substantial volume. Stores of pig iron at makers' yards have not increased to an extent that threatens to weaken the strong statistical position of ironmasters, who are determined to restrict output to current needs and not again to afford outside speculators opportunity to acquire sufficient iron to enable them to control the market. The bulk of the iron produced goes into direct use in its molten state at makers' own foundries and steel works, and the surplus output that is run into the pig beds promises to be well taken up by home users. Prices are firmly maintained, No. 1 foundry iron being 75s., No. 3 G.M.B. 72s. 6d., and No. 4 forge 71s. 6d.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade is a little easier, though makers' stocks are understood to be well sold, and some producers have disposed of a good deal of their output for forward delivery. Mixed numbers are quoted at from 78s. 6d. to 79s. for early delivery, but 80s. and upwards is asked for forward contracts.

Ironmaking Materials.

There is an easier feeling in the foreign ore trade, but transactions are confined to sales of spot cargoes, and terms on which contracts over a period might be made are

difficult to ascertain. Consumers are quite well bought. Durham blast-furnace coke is in ample supply and weak in price. Good medium qualities are now barely 22s. 9d. per ton delivered at the works in this district.

Manufactured Iron and Steel.

The steel makers are all optimistic. They have a good volume of orders to execute, and buyers seem willing to follow the recent rise in prices. Output is heaviest in departments manufacturing shipbuilding requisites, bridge building material, and necessaries for railway construction. Prices are unchanged.

The Coal Trade.

A favourable view is taken of the outlook for the Northern coal trade over the next few weeks. Coal shipments are proceeding briskly at North-East Coast ports, and the tonnage supply is adequate to meet the flow of orders. Fortunately, for traders definitely wanting coal there is no special pressure of new inquiries, and in the absence of any acute competition for the little prompt coal available prices are stationary. Fitters are firmly situated, some having sold practically the entire output for January, but while they indicate maximum quotations, these are purely nominal and coal is obtainable second hand at lower prices. Best Northumberland steams, for example, which are quoted direct at 17s. 6d., are reported to have changed hands through merchants in one instance at 16s. 10½d. Generally speaking, the Northumberland steam coal trade continues on good steady lines. For smalls the tone is very favourable, and from 10s. 6d. for seconds, the price basis ranges up to 11s. 6d. for best and special descriptions. Durham gas and coking collieries have every prospect of a busy month and full working time. Orders already booked are of substantial dimensions and inquiries are coming forward more freely. Prices are quoted firm and unchanged for best gas coals at 17s., with special kinds at 17s. 6d. Coking unscreened is firm at 15s. 6d. to 16s., and bunker coal producers quote steadily for more forward deliveries. The coaling stations are taking increased supplies. Good class Durham unscreened bunker coals are quoted at 15s. 6d., and superior grades at from 16s. 3d. to 17s. 3d. In the coke section there are no signs of any increase in the demand for blast-furnace kinds. Patent foundry makes also meet with a poor request just now, and while producers have considerable bookings there is a good surplus of this fuel on offer at 21s. to 22s., according to grade. Special foundry coke is steadily placed at 28s. to 32s. Gas coke is extremely scarce under a low output and firmly priced at 25s. 6d. to 26s.

Blast-furnacemen's Wages Advanced.

The wages of blast-furnacemen on the North-East Coast have been advanced by 2¾ per cent. as a result of the ascertainment issued by the Cleveland Ironmasters' Association this week. They are now 14 per cent. above the standard. The ascertained price of No. 3 Cleveland pig iron, which governs the men's wages under a sliding scale, was certified at 68s. 2·71d. per ton for the last quarter of 1929, as compared with 65s. 5·92d. per ton for the preceding quarter. The wages have steadily advanced since June of last year, when they were 8¾ per cent. above the standard.

SCOTLAND.

(From our own Correspondent.)

Steel and Iron.

MARKETS continue under the holiday influence. Some works have already reopened, but a general resumption will not be made before Monday, January 13th. Consequently, business will not assume anything approaching normal proportions for another week or ten days. Business during the past year has at its best been only moderate, and the outlook for 1930 is not too inspiring. Producers extract some encouragement from the more stable appearance of continental markets, which it is hoped may materially lessen the competition which has told heavily against them in many markets. If home prices could be reduced a little, profits might be more rapidly realised, but the tendency has been all in the other direction. Steel and pig iron prices were increased last December, and in all probability if the Coal Bill passes further increases may be found necessary. Unless the unforeseen happens, it is therefore difficult to see how the general position will benefit to any extent from a fixed minimum level of prices on the Continent, so long as the gap between the relative home and continental values is as large as it is at present. While prospects on the whole may not have improved, some districts are assured of a fairly successful year. One or two concerns in Lanarkshire have obtained considerable orders for steel material, and there is a possibility that others may follow suit. At the moment, however, prospects with regard to the ironworks are not encouraging. Bar iron has been more or less stagnant for a considerable period, and nothing has occurred calculated to relieve the depression. Similar conditions pertain in the re-rolled steel bar departments. Prices of re-rolled steel bars are still in the region of £7 12s. 6d. per ton, home or export. Pig iron has been a dull market for a long time, and there seems little hope that the output will have to be increased. Costs are heavy and the production is kept at a minimum.

Coal.

Owing to a pressure of orders some Lanarkshire collieries reopened immediately after New Year's Day. Many of the collieries in other districts have comparatively good order books, and the holidays will not be of long duration. The total shipments from Scottish coalfields during 1929 amounted to 13,280,603 tons, compared with 11,870,460 tons in 1928. The market has been practically at a standstill throughout the past few days, and prices were not tested and are therefore nominally unchanged.

Contracts for Johnstone Firm.

Loudon Brothers, Ltd., Johnstone, Renfrewshire, have secured an order for a number of rail planing machines from a home railway company, and have also on hand orders for a considerable number of their "super-speed" machines for marine and naval construction work, and several wheel lathes for Dominion and South American railways.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE exceptionally heavy loading pressure at South Wales ports experienced recently is easing down, though considerable activity still prevails. Still the position is not so strong from the colliery point of view; in fact, the conditions are irregular, and some undertakings are in need of a prompt outlet for some of their coals, while others find it difficult to cope with the demands made upon them. The supply of tonnage now to hand is unevenly distributed, as is usually the case. At the end of last week there were eleven idle tipping appliances at the various docks and twenty-two steamers waiting to berth, while, as the result of week-end arrivals, the position on Tuesday was that three tips were idle, while the number of waiting vessels was still twenty-two, the majority of which were at Swansea and Port Talbot. This shows that the pressure is mostly at the ports where anthracite descriptions are shipped, while, on the other hand, at the ports of Cardiff, Penarth, Barry, and Newport, the conditions are not so satisfactory from the point of view of the collieries which produce steam coals. The current demand for the latter has certainly not opened very well for the New Year; in fact, the conditions can only be described as very quiet, but there is, of course, more going on than appears on the surface, as it is very well known that more tonnage is chartered on voyages at the present time than has been the case in recent years, and coals are being lifted on contract on a very fair scale. Contracts are expected to be signed this week on behalf of the Italian State Railways for round about three-quarters of a million tons of Monmouthshire coals, this order being placed in accordance with the undertaking of the Italian Government under the Hague coal agreement of last August to purchase 1,000,000 tons annually for three years. It is reported that the firms which have secured the business now being placed are the Powell Duffryn Steam Coal Company, Ltd., T. Beynon and Co., Ltd., Partridge, Jones and Co., Ltd., and the Risca Sirhowy Colliery. It is understood that the coals will be shipped as far as possible in Italian-owned tonnage, which will be chartered in Italy.

South Wales Trade.

The Great Western Railway Company has issued preliminary returns of the sea-borne traffic at the six ports in this district under its control, and they show that the traffic last year was the heaviest since 1923, when it was 44·4 million tons. The figures for 1929 reveal that coal and coke exports came to 29,836,000 tons; other exports, 3,444,000 tons; and imports, 5,187,000 tons; making a total of 38,467,000 tons. The figures for 1928 were coal and coke exports, 26,376,143 tons; other exports, 3,330,896 tons; and imports, 4,949,254 tons; making a total of 34,656,293 tons. The improvement in traffic last year was mainly due to the increased activity in coal and coke shipments, the advance being nearly 3¾ million tons.

Steel Industry and Rationalisation.

The news regarding the Ebbw Vale undertaking is not at all cheering, inasmuch as at the end of last week confirmation was forthcoming that notices had been served to all the officials, which means the closing down of the steel works. According to Sir John Beynon, the new chairman of the company, they cannot restart the steel works under six months, even if the position were to improve sufficiently to justify it. It is not possible to carry on the steel side of the industry and, at any rate for some time to come, they have no option but to concentrate on the coal side of the undertaking. Another development concerns the iron and steel interests in South Wales of Guest, Keen and Nettlefold's, Ltd., and Baldwin's, Ltd. The official announcement is made that these two important concerns have agreed, subject to the necessary consents being obtained and the preparation of a detailed scheme, to form a company to take over and operate as from the 1st inst., the coke ovens, blast-furnaces, steel works, and heavy steel rolling mills of the two companies, situated mainly at Cardiff, Dowlais, Margam and Port Talbot. The board of the new company will be appointed by Guest, Keen and Nettlefold's, Ltd., and Baldwin's, Ltd., and it is understood that Sir John Field Beale—chairman of the former—and Sir W. Charles Wright—chairman of the latter—will be the chairman and deputy-chairman respectively. The capital of the new company will be subscribed by the two undertakings in question. The other enterprises of the two companies will not be affected by the decision now come to. Incidentally, it may be mentioned that Mr. William Simons, the general manager of the Cardiff and Dowlais works of Guest, Keen and Nettlefold's, Ltd., was last week elected a director of the undertaking. He is regarded as one of the best authorities on steel in the United Kingdom.

Colliery Acquisition.

It is reported that Cory Brothers, Ltd., of Cardiff, have purchased the Rhondda Main Colliery, Ogmore Vale, which belonged to Lewis-Merthyr, Ltd., and was closed down about five years ago. It is estimated that Lewis-Merthyr, Ltd., spent a million and a-quarter pounds on this colliery. No definite information is forthcoming as to when the colliery will be reopened for work, but in view of its having been idle for so long, it must necessarily be some time before it can be restored to a condition to enable a restart to be made.

Ship-repairing Order.

Another substantial ship-repairing order has gone from this district. It is in respect to the ss. "Don," which, as the result of being stranded during the recent gales on the beach at Aberavon, sustained extensive damage. The order has been secured by the Wilton Engineering and Slipway Company, of Rotterdam, which has undertaken to do the work in thirty-five running days—including the time taken to tow the steamer from Port Talbot to Rotterdam—at a cost of £8100. It is understood only one South Wales firm tendered for the contract, and it is stated that other firms, being fairly busy, preferred not to block their dry docks with a long job in view of their commitments in other directions.

Spelter Works.

As the result of voluntary concessions by the workmen, it is reported that the management of the English Crown Spelter Works, Swansea, has decided to continue full operations for at least another three or four months. Five weeks ago the workmen received notices terminating their contracts, but they were suspended last week, and the men were engaged on day to day contracts.

Current Business.

The general tone of the steam coal market at the moment is quiet, and comparatively little new business is being done. Dry coals and Monmouthsire qualities are, however, very steady, but other descriptions of large display a certain amount of irregularity. Smalls and sized coals still retain their firmness. Patent fuel is well stemmed. Owing to failure to agree on the terms of the employers concerning a reduction in wages and an alteration in working conditions, the workers at the patent fuel undertakings at Swansea were idle on Wednesday last. It is feared there may be a stoppage for a fortnight or more unless the workmen concede the employers' demands in the meantime. About 700 men are affected. The pitwood market is quiet, at round about 28s. 6d. to 29s.

CALENDARS, DIARIES, &c.

BRITISH BROWN-BOVERI, Ltd., London.—Wall calendar with monthly sheets.

COUNTY OF LONDON ELECTRIC SUPPLY COMPANY, Ltd., County House, New Broad-street, London, E.C. 2.—Telephone card.

CARRIER-ROSS ENGINEERING COMPANY, Ltd., Victory House, Regent-street, London, W.—Wall calendar with monthly tear-off slips.

CROSSLEY BROS., Ltd., Openshaw, Manchester.—Wall calendar with monthly tear-off sheets.

IRONITE COMPANY, Ltd., 11, Old Queen-street, S.W. 1.—Wall calendar with monthly tear-off sheets.

FRIED. KRUPP A.G. (Agents, J. F. Melling, Ltd., 11, Victoria-street, S.W. 1).—Pocket diary.

RANSOMES AND MARLES BEARING COMPANY, Ltd., Newark-on-Trent.—Wall calendar with tear-off slips.

C. ROBERTS AND CO., Ltd., Horbury Junction, near Wakefield.—Three desk calendars with daily tear-off slips.

S. S. STOTT AND CO., Haslingden, near Manchester.—Wall calendar with monthly tear-off sheets.

SUPERHEATER COMPANY, Ltd., Bush House, Aldwych, W.C. 2.—Wall calendar with monthly tear-off slips.

EDWARD WOOD AND CO., Ltd., Ocean Ironworks, Manchester.—Wall calendar with monthly tear-off slips.

SUBMARINE SIGNAL CORPORATION, 9, Victoria-street, Westminster, S.W. 1.—Wall calendar with monthly tear-off sheets.

WAILES DOVE BITUMASTIC, Ltd., Collingwood Buildings, Newcastle-on-Tyne.—Pocket diary.

WELIN MACLACHLAN DAVITS, Ltd., 40, St. Vincent-place, Glasgow, C. 1.—Refill for desk calendar.

WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY, 2, Norfolk-street, Strand, W.C. 2.—Pocket diary.

EDWARD WOOD AND CO., Ltd., 81, Cannon-street, London, E.C. 4.—Pocket diary.

LAUNCHES AND TRIAL TRIPS.

ATHELLAIRD, twin-screw motor tanker; built by Cammell Laird and Co., Ltd., to the order of United Molasses Company, Ltd.; dimensions, 475ft. by 63ft. by 35ft.; to carry 13,000 tons. Engines, Burmeister and Wain Diesels; constructed by J. G. Kincaid and Co., Ltd.; launch, December 18th.

FORTHBANK, cargo steamer; built by Workman, Clark (1928), Ltd., to the order of Messrs. Andrew Weir and Co. for their Bank Line services; dimensions, 420ft. by 56ft. 6in. by 36ft. 3in. Engines, quadruple-expansion, 22in., 32in., 46½in., 68in. by 48in. stroke, pressure 260 lb. per square inch; constructed by the builders; trial trip, December 18th.

MENESTHEUS, twin-screw motor vessel; built by Caledon Shipbuilding and Engineering Company, Ltd., to the order of Messrs. Alfred Holt and Co., Liverpool; dimensions, 462ft. by 59ft. by 35ft. 3in.; to carry cargo and a few passengers. Engines, Diesels; constructed by Burmeister and Wain; trial trip, December 18th.

ALICE, twin-screw motor yacht; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Sir Richard A. Cooper, Bart., of Boxmoor, Herts; dimensions, 145ft. by 27ft. by 9¼ft. Engines, two sets Sulzer Diesel engines, built to the order of the Wallsend Slipway and Engineering Company, who installed them; trial trip, December 19th.

BARCELONA, twin-screw motor cargo vessel; built by Harland and Wolff, Ltd., to the order of the Argentine Navigation Company (Nicolas Mihanovich), Ltd.; dimensions, 275ft. by 43ft. by 13ft. Engines, Harland-B. and W. motors; launch, December 19th.

YEARBY, steamer; built by Wm. Gray and Co., Ltd., to the order of Sir R. Ropner and Co., Ltd.; dimensions, 448ft. 7in. by 55ft. 6in. by 31ft. 1in.; to carry cargo. Engines, triple-expansion, 26½in., 44in., 73in. by 48in. stroke, pressure 180 lb. per square inch; constructed by the builders; trial trip, December 19th.

FLOATING DOCK; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Bengal and North-Western Railway; dimensions, 210ft.; to lift 500 tons. This dock has been shipped to India.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/6 to 22/–
(1) Spanish	23/– to 24/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (o.i.f.)	24/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 1 0	—
No. 1 Foundry	4 0 6	—
No. 3 Foundry	3 18 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 18 6	3 18 6
No. 1	3 19 0	3 19 0
Cleveland—		
No. 1	3 15 0	3 15 0
Silicious Iron	3 15 0	3 15 0
No. 3 G.M.B.	3 12 6	3 12 6
No. 4 Foundry	3 11 6	3 11 6
No. 4 Forge	3 11 0	3 11 0
Mottled	3 10 6	3 10 6
White	3 10 6	3 10 6
MIDLANDS—		
(3) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 15 6	—
„ „ Foundry	3 19 6	—
(3) Northampton—		
Foundry No. 3	3 15 0	—
Forge	3 11 0	—
(1) Derbyshire—		
No. 3 Foundry	3 18 6	—
Forge	3 14 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 13 6	—
No. 4 Forge	3 9 6	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 7 6 (*a*) / 4 9 6 (*b*) / 4 13 9 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	13 0 0	12 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	8 5 0 to 8 7 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	10 0 0	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 15 0	—
Hoops	9 15 0 to 10 5 0	—
Soft Wire Rods	8 0 0	—
MIDLANDS—		
Small Rolled Bars	8 2 6 to 8 15 0	—
Billets and Sheet Bars	6 5 0 to 6 12 6	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	12 5 0 to 12 15 0	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/9 to 19/–
Block Tin (Cash)	176 2 6
„ (three months)	179 5 0
Copper (cash)	71 10 0
„ (three months)	69 17 6
Spanish Lead (cash)	21 18 9
„ „ (three months)	21 10 0
Spelter (cash)	19 12 6
„ (three months)	20 5 0
MANCHESTER—	
Copper, Best Selected Ingots	78 5 0
„ Electrolytic	83 15 0
„ Strong Sheets	110 0 0
„ Tubes (Basis Price), lb.	0 1 3
Brass Tubes (Basis Price), lb.	0 1 1
„ Condenser, lb.	0 1 3
Lead, English	23 2 6
„ Foreign	21 9 9
Spelter	19 15 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/4½ per lb.	
Ferro Tungsten	3/1½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
„ „ 6 p.c. to 8 p.c.	£22 0 0	6/6
„ „ 8 p.c. to 10 p.c.	£21 17 6	6/–
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£33 0 0	10/–
„ „ „ 1 p.c. carbon	£39 0 0	15/–
„ „ „ 0·70 p.c. carbon	£41 0 0	15/–
„ „ „ carbon free	1/– per lb.	
Metallic Chromium	2/6 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home; £13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 0 0 scale 7/– per unit	
„ Vanadium	12/10 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	1/– per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/–
„ „ Ell	16/6
„ „ Splint	16/9 to 18/–
„ „ Trebles	17/6
„ „ Doubles	17/–
„ „ Singles	14/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/6
„ „ Jewel	17/6
„ „ Trebles	17/6
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	15/– to 16/6
Screened Navigation	18/– to 19/6
Trebles	18/6 to 19/6
Doubles	17/– to 17/6
Singles	15/–
LOTHIANS—	
(f.o.b. Leith)—Best Steam	15/–
Secondary Steam	14/3
Trebles	18/–
Doubles	16/6
Singles	14/9

ENGLAND.

(8) N.W. COAST—	
Steams	21/6 to 23/–
Household	38/– to 51/–
Coke	27/6
NORTHUMBERLAND—	
Best Steams	17/3 to 17/6
Second Steams	16/–
Steam Smalls	11/3
Unscreened	13/– to 13/6
Household	25/– to 37/–
DURHAM—	
Best Gas	17/–
Second	15/3 to 15/6
Household	25/– to 37/–
Foundry Coke	25/– to 30/–
SHEFFIELD—	Inland.
Best Hand-picked Branch	26/6 to 28/–
Derbyshire Best Bright House	21/– to 23/–
Best House Coal	20/6 to 21/6
Screened House Coal	18/6 to 20/–
„ „ Nuts	16/6 to 18/–
Yorkshire Hards	15/6 to 17/–
Derbyshire Hards	15/6 to 17/–
Rough Slacks	9/– to 10/–
Nutty Slacks	7/6 to 8/6
Smalls	3/– to 5/–
Blast-furnace Coke (Inland)	17/– on rail at ovens
Furnace and Foundry Coke (Export), f.o.b.	24/– to 24/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	20/– to 20/3
Second Smokeless Large	18/9 to 20/–
Best Dry Large	20/6 to 21/–
Ordinary Dry Large	20/– to 20/6
Best Black Vein Large	18/9 to 19/–
Western Valley Large	18/6 to 18/9
Best Eastern Valley Large	18/3 to 18/6
Ordinary Eastern Valley Large	17/9 to 18/–
Best Steam Smalls	14/3 to 14/9
Ordinary Smalls	13/– to 14/–
Washed Nuts	19/6 to 32/6
No. 3 Rhondda Large	20/3 to 21/–
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/3 to 17/6
„ „ Through	15/6 to 16/6
„ „ Smalls	14/3 to 14/9
Foundry Coke (Export)	32/6 to 37/6
Furnace Coke (Export)	29/– to 30/–
Patent Fuel	22/– to 22/6
Pitwood (ex ship)	28/3 to 28/9
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	36/– to 38/–
Seconds	30/– to 32/6
Red Vein	26/– to 28/–
Machine-made Cobbles	43/6 to 45/6
Nuts	45/– to 47/6
Beans	27/– to 29/–
Peas	20/– to 20/6
Breaker Duff	10/9 to 11/3
Rubbly Culm	12/9 to 13/6
Steam Coals :	
Large	20/6 to 21/6
Seconds	18/6 to 19/6
Smalls	13/6 to 14/6
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 12/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(*From our Correspondent in Paris.*)

The Trade Future.

THERE are many factors which raise some doubt whether the activity that was observable down to the end of 1929 will be continued during the present year. The steadily widening margin between imports and exports is regarded as a disturbing feature, but it is attributable to two things—an increase in the imports of coal and a heavy decline in the value of manufactured goods, although there has been a small increase in quantity. The coal imports during the first eleven months of last year amounted to 27,648,000 tons, an increase, as compared with the similar period of 1928, of 5,766,000 tons. This may have been due to the industrial activity at home. At the same time, the obligation of Germany to send 7,000,000 tons of coal a year to France for reparations now ceases, and that removes one obstacle to trade in British coal. The increasing production costs would also seem to weigh heavily upon the future of industry. As the export trade is declining and the home consumption, apart from building material, is diminishing, the outlook would be unpromising if it were not for the remarkable number of public works to be put in hand at home and in the colonies. Directly it was seen that the participation of Germany in the carrying out of public works was to be considerably reduced the Government took measures to ensure a continuance of the works already in hand and the execution of many others affecting hydro-electric supply, railways, ports, roads and inland waterways. It has also undertaken to guarantee a first loan of 3600 million francs for works to be carried out in French West Africa, which will include the construction of a barrage on the Niger at Sansanding for the irrigation of a vast territory for the cultivation of cotton and rice and the creation of a wool growing industry. It is intended to remove the present dependency of the Niger Valley upon British Nigeria for transport by constructing a railway through French territory to Dahomey. The scheme of colonial development is a very comprehensive one, and there are so many undertakings ready to be put in hand that work is likely to be plentiful all through the year, provided that money is forthcoming to carry them out.

Aviation.

The work of the Air Ministry during the past year was mainly one of reorganisation, and with the division of the country into four sectors, each under separate authorities, and a closer association of the naval and military air services, all being directly dependent upon the Air Ministry, everything is now ready for a more active development of all those different departments. The Ministry has also control over the civil air services, and a plan has been prepared for fostering public interest in aviation and for extending a system of services which will eventually link up all parts of the French Empire. Reforms have been carried out in the commercial and technical methods of the air services. For the present year the credits for aviation have been considerably increased and are second only to those for military defence. The sum to be spent upon new machines is 400 million francs.

Works Equipments.

One of the leading engineering companies has decided to increase its capital with a view to the laying down of new plant and improving the factory equipment generally. The company in question has always been particularly successful in securing foreign orders for bridge work, sugar making machinery and the like, but of late conditions have changed with advancing wages and higher costs, and the directors have come to the conclusion that the increased wages can only be met by economy in manufacturing methods. France is one of the few countries in which the engineering industries have remained busy, and they are still assured of employment for a long time to come. In a general way works have been entirely modernised. Those in the northern departments had to be reconstructed after the Armistice, and the most efficient machinery and plant were put down. In other parts of the country some works have been equipped with German machinery on account of reparations. In the motor car factories, especially, nothing is neglected to ensure a maximum output with the use of machinery. It is particularly noteworthy that a huge works in the Nord, which was reconstructed a decade ago, should find it necessary to spend a considerable sum of money upon improvements, and it confirms the general belief amongst manufacturers that they must take measures against rising wages, increased costs and labour scarcity.

The Rhone Scheme.

The Department of the Seine has offered to contribute its share of the capital required to form a company to carry out the navigation and other works on the Rhone, on condition that the company is definitely constituted within a certain time. The interests of the Department of the Seine in the venture lies in its option upon a quantity of current to be supplied by the hydro-electric works. The remainder of the capital will be contributed in equal parts by the P.L.M. Railway Company, the other Departments interested and by industrial groups. The programme, however, is still unsettled, for while there is one proposal to deepen the river for navigation and construct lateral canals where necessary, another scheme, sanctioned especially by the Marseilles Chamber of Commerce, is to construct a lateral canal all the way from Lyons to Marseilles so as to permit of the navigation of boats of bigger tonnage more economically and at higher speeds than would be possible upstream on the river. So far as concerns the production of electrical energy and the irrigation of the arid territory of the Carmague, the plans are practically completed, but navigation on a fast-flowing and, in places, tortuous river like the Rhone presents a serious problem.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

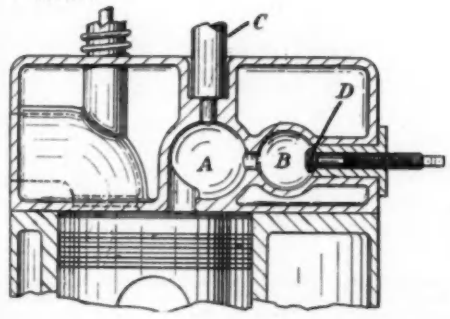
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

322,097. November 29th, 1928.—COLD-STARTING ENGINES, R. A. Lister and Co., Ltd., and A. F. Sanders, Dursley, Glos.

The object of this invention is to facilitiate the starting of oil engines "from cold" by temporarily increasing the compression ratio. The clearance volume of the cylinder is comprised in the two spherical chambers A and B in the cylinder head, the combined capacity of which is proper for the normal running of the

Nº322,097



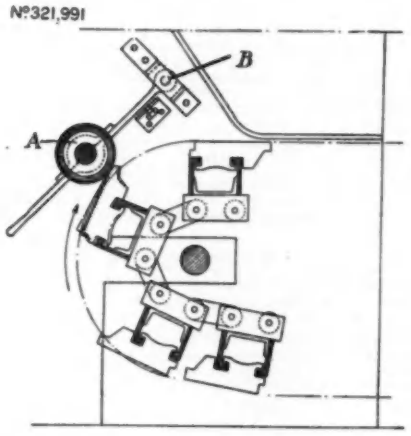
engine. The fuel valve is shown at C. Before starting up, the valve D is screwed forward so that it closes the communicating passage between the chambers A and B and thus reduces the clearance volume and so increases the compression ratio that ignition is assured. When the engine is under way the valve is screwed back to open the second chamber, and is tightened on its back seating to prevent leakage of gas along its stem.—*November 28th*, 1929.

FURNACES.

321,991. August 25th, 1928.—TRAVELLING GRATE STOKERS, *Babcock and Wilcox, Ltd., Farringdon-street, London, E.C.* 4.

The object of this invention is to clean the bars of a chain grate stoker of slag and clinker, which may adhere to them. To this end there is mounted, at the front of the stoker, a heavy

Nº321,991



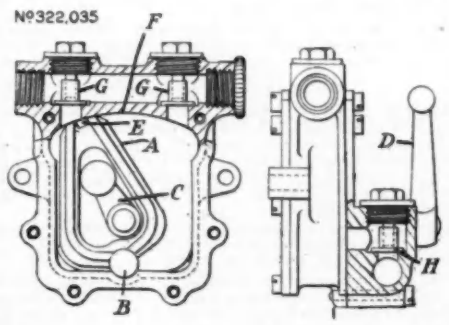
roller A supported by links pivoted at B. The surface of this roller is furnished with ribs, which do not embrace the whole circumference, and are staggered from rib to rib. These ribs break up the clinker as the bars pass and keep the grate clean.—*November 25th*, 1929.

PUMPING AND BLOWING MACHINERY.

322,035. September 27th, 1928.—SEMI-ROTARY PUMPS, A. G. Langdon, 77, Derby-road, Northam, Southampton.

In this pump the sector-shaped vane A rocks about the pivot

Nº322,035



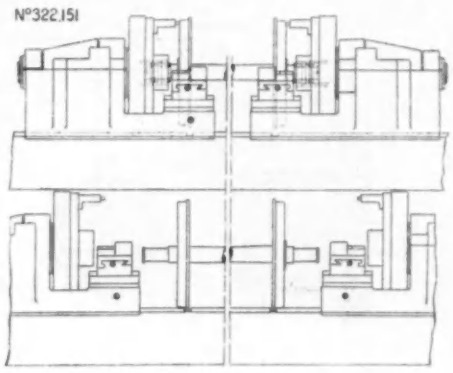
B and is operated by the crank C and hand lever D. It is so formed that at either end of its stroke it comes almost into contact with the walls of the pump chamber, and is provided with a packing strip E to make a tight joint against the curved surface F. The delivery valves are shown at G and one of the suction valves at H.—*November 28th*, 1929.

MACHINE TOOLS AND SHOP APPLIANCES.

322,151. April 17th, 1929.—RAILWAY WHEEL LATHES, Loudon Bros., Ltd., Clyde Engineering Works, Johnstone, Renfrew; and G. H. Buchanan.

This invention consists broadly in a railway wheel lathe comprising essentially a bed and two headstocks, each movable endwise of the bed and each unitary with a slide rest, the arrange-

Nº322,151



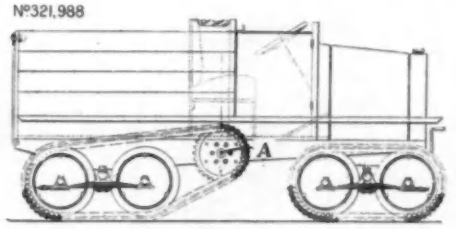
ment being such that the slide rests are movable concomitantly with the headstocks towards and away from the wheels so as, when the headstocks are in operative position, the slide rests are opposite the wheels and, when the headstocks are moved to release the wheels, the slide rests are so disposed as to permit unobstructed passage of the wheels between them.—*November 28th*, 1929.

MOTOR CARS AND ROAD TRAFFIC.

321,988. August 24th, 1928.—ENDLESS TRACK VEHICLES, Vickers-Armstrong Ltd., Vickers House, Broadway, Westminster, and J. V. Carden, 166, Piccadilly, Westminster.

There are two peculiarities about this caterpillar tractor.

Nº321,988



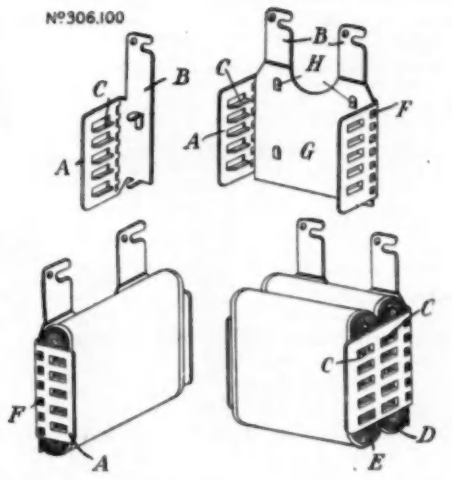
One is that the rear tracks are extended to embrace the driving sprocket A, so that they are driven directly. The other is that the carrying wheels are mounted directly on the ends of flat laminated springs. Provision is made at one end of the spring for taking up slack in the track chain.—*November 25th*, 1929.

MISCELLANEOUS.

306,100. February 15th, 1929.—ELECTRIC CONDENSERS, Elektrizitäts-Aktiengesellschaft Hydrawerk, of Windscheidstrasse 18, Charlottenburg, Berlin, Germany.

This invention relates to electric condensers of the laminated or rolled type, in which the metallic electrodes are extended beyond the di-electric to serve for connection purposes, and the invention is particularly concerned with an improved form of contact clip for a condenser of this kind. The contact piece A is constructed in the form of an angle bracket with an extended portion B serving as a terminal strip. It possesses

Nº306,100

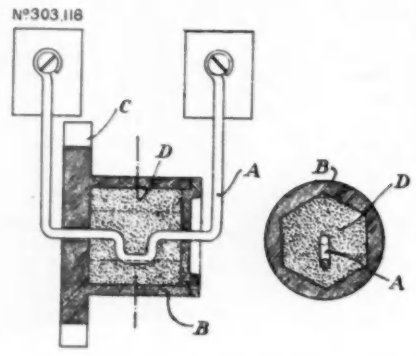


pressed-out projections C of any desired shape, the edges of which are advantageously made sharp and are adapted to engage the projecting edges D E of the condenser unit. At or near the angle of the bend, apertures F are provided in order to render the angle pieces elastic. As shown in the top right-hand drawing, two contact pieces are attached to one insulating plate G by means of their stamped out tags H, by which means a contact clip is formed, and in it the condenser unit is supported as shown in the bottom left-hand drawing. The clamp in effect enhances the good electrical contact between the projections C and the projecting edges of the condenser electrodes.

The contact pieces also render possible the parallel connection of two or more condenser units. In this case the contact pieces A are provided with as many rows of pressed-out projections C as there are elements to be connected up in parallel, as shown in the bottom right-hand drawing.—*November 21st*, 1929.

303,118. December 27th, 1928.—ELECTRO-THERMAL RELEASE DEVICE FOR ELECTRIC SWITCHES, Schiele and Bruchsaler Industriewerke Aktiengesellschaft, of Baden-Baden, Germany.

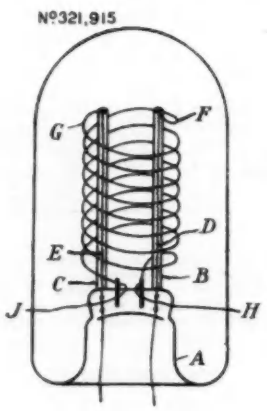
The heating wire A carries a drum B or other hollow body which is formed with teeth C. The interior D of the drum is filled with a fusible mass, preferably an eutectic alloy. The walls bounding the space D are made other than cylindrical,



so that the drum cannot rotate when the fusible mass is in cold condition. When the heating wire A reaches a definite temperature the mass is melted and the drum B is free to rotate, a portion of the heating wire A being formed as a crank. The effect is to release a switch. In the releasing device shown, and in which the greatest dimension amounts to fractions of a centimetre, results can be obtained with a heating energy of about 0·6 watts. —*November 28th*, 1929.

321,915. July 13th, 1928.—ELECTRIC DISCHARGE TUBES, *Stanley Gordon Sinclair Dicker, of* 20 *to* 23, *Holborn, London, E.C.* 1.

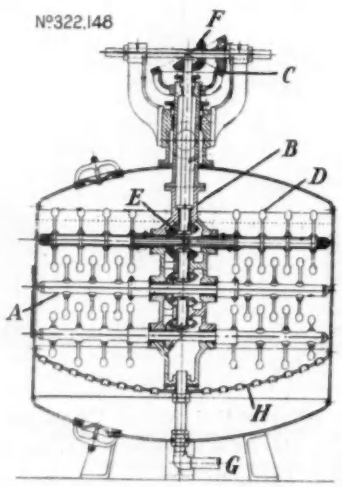
This invention relates more particularly to cathode glow discharge tubes with cold electrodes containing mercury vapour. The object is to cause the metal vapour enclosed within the discharge tube to take part intensively in the discharge. The wall of the cathode glow discharge lamp is composed of a material that is transparent to ultra-violet rays. The stem A has two small insulating tubes B and C, which contain heating elements



D and E, constituted, for example, by helically wound tungsten wires connected to the electrodes F and G, which are helically wound together and are supported at their upper ends by the tubes B and C and at their lower ends by supporting rods H and J. The tube contains argon, *e.g.*, at a pressure of 25 mm. of mercury, and mercury vapour which, during the operation of the tube, is heated by the heating element and attains a high pressure, *e.g.*, 0·1 mm., so that an intense ultra-violet radiation is ensured. The heating elements serve at the same time as current limiting resistances.—*November 13th* 1929.

322,148. April 2nd, 1929.—MECHANICAL FILTERS, S. J. Ricks and C. E. Douglas, 213, Cecil Chambers, 76, Strand, London, W.C. 2.

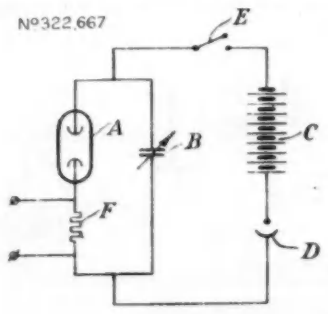
In this mechanical filter an effort is made to stir up the whole



of the bed of sand during the cleaning cycle. The stirrer arms A are mounted on a sleeve B, which is driven by the bevel gear C. On each arm there is a series of paddles D, which are driven by the bevel gearing E within the sleeve and the drive F at the top. It will be seen that the drive for the paddles is transmitted downward by short intermediate shafts, so that the alternate rows of paddles rotate in opposite directions. At the ends of the paddle arms there are nozzles, which are supplied with water through the branch G, to break up any sand that may adhere to the filter casing. During cleaning water is, of course, forced upwards through the nozzle plate H.—*November 28th*, 1929.

322,667. January 1st, 1929.—ARRANGEMENTS FOR MODULATING THE FREQUENCY OF ELECTRIC OSCILLATIONS, *Stanley Gordon Sinclair Dicker, of* 20 *to* 23, *Holborn, London, E.C.* 1.

This invention relates to circuit arrangements employing light-sensitive cells. In well-known devices of this character these cells are inserted in a circuit in which the current strength varies as the intensity of the light incident on the cells. In order to obviate the difficulty which is encountered in amplifying these currents, various circuit arrangements have been devised in which modulation of high-frequency oscillations is resorted to. The invention has for its aim to enable a light-sensitive cell to be inserted in a circuit arrangement in such a manner that frequency modulation of electric oscillations is ensured. A neon tube A is connected in parallel with a condenser B and a source of direct current, such as a battery C, and a light-sensitive cell D are connected in series with this parallel group. When the current is established by a key E the full battery voltage is impressed



on the neon tube. The latter breaks down and the condenser is thus substantially short circuited. In consequence of ionisation by collision in the neon tube the current in the circuit increases and thus the potential drop across the light-sensitive cell increases to such an extent that the voltage across the terminals of the neon tube falls below the operating voltage. The discharge ceases, the short circuit of the condenser B is removed and the latter becomes charged up until the breakdown voltage of the neon tube A is attained, after which the operation described is repeated. The frequency of the oscillations occurring at the terminals of the resistance F, which are termed relaxation oscillations, is dependent upon the value of the condenser B and of the resistance of the light-sensitive cell D. When light variations are applied to the light-sensitive cell, the resistance of the cell will undergo variations and the frequency of the relaxation oscillations is consequently modulated correspondingly to the light variations.—*December 12th*, 1929.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

CHEMICAL ENGINEERING GROUP.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W. 1. "Autogenous Welding in Chemical Works," by Mr. J. R. Booer, B.Sc. 8 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN STUDENTS' SECTION.—Armstrong College, Newcastle-on-Tyne. "Modern Telegraph Practice," by Mr. G. W. Hastings. 7.15 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. "The Track Circuit in Railway Signalling," by Mr. H. J. N. Riddle. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. "'Design and Construction of the Rail Car Carrying Steamship 'Seatrain,'" by Mr. L. C. Burrill, B.Sc. 6 p.m.

MONDAY, JANUARY 13TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Extrusion, and a Consideration of Some of the Physical Properties Affecting the Production of Rods, Tubes and Sections of this Process," by Mr. A. Wragg. 7.30 p.m.

INSTITUTE OF TRANSPORT.—At the House of the Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. At this meeting Mr. Ashton Davies will submit for discussion a paper on "The Co-ordination of Transport," instead of upon the subject originally selected, namely, "Air Transport in Relation to Railways." 5.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. "Petrol-electric Vehicle Characteristics," by Mr. C. R. F. Engelbach. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—At Armstrong College, Newcastle-upon-Tyne. "Voltage Control of Large Alternators," by Mr. H. W. Taylor. 7 p.m.

TUESDAY, JANUARY 14TH.

ASSOCIATION OF EX-SIEMENS' MEN.—Gatti's Restaurant, King William-street, Strand, W.C. 2. Smoking concert.

GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. The following paper will be read and discussed, "Some Recent Developments in the Treatment of Fine Coal," by Mr. Arthur Grounds. 4 p.m. The Council will meet at 3 p.m.

INSTITUTE OF MARINE ENGINEERS.—The Minories, London, E.C. 3. "Water-tube Boilers for Merchant Ships," by Engineer Rear-Admiral W. M. Whayman. 6.30 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Chromium Plating," by Mr. L. Wright. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—King's Head Hotel, Coventry. "Commercial Aluminium Alloys from the Users' Point of View," by Mr. J. B. Hoblyn. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Paper to be submitted for discussion, "Railway Traction by Oil Engines," by Mr. A. E. L. Chorlton. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—The Hotel Metropole, Leeds. Informal discussion on "Colliery Electrification," opened by Mr. I. Scott Mackenzie. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—At the North British Station Hotel, Edinburgh. "The Heating of Buildings Electrically by Means of Thermal Storage," by Lt.-Colonel S. E. Monkhouse and Mr. L. C. Grant. 7 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. Extraordinary general meeting, 7.30 p.m.; annual general meeting, 7.45 p.m. Presidential address.

WEDNESDAY, JANUARY 15TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. Graduates' meeting. "Air Cleaners," by Mr. R. W. Bent. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Informal meeting. Subject for discussion, "Developments in Transportation by Cableways," by Professor Stephen Mitchel Dixon. 6 p.m.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington, S.W. 7. Ordinary meeting for the election of Fellows at 7.30 p.m. Annual general meeting. Presentation of the Symons Medal to Dr. G. C. Simpson, F.R.S. Address on "Weather Cycles and Weather Recurrences," by Sir Richard Gregory. 7.40 p.m.

ROYAL MICROSCOPICAL SOCIETY.—20, Hanover-square, London, W. 1. Presidential address, "Resolution and Visibility in Medical Microscopy," by Mr. Joseph E. Barnard, F.R.S. 7.30 p.m.

THURSDAY, JANUARY 16TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the Chamber of Commerce, New-street, Birmingham. "Modern Annealing Furnaces," by Mr. J. Fallon. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: LONDON GRADUATES.—Watergate House, Adelphi, W.C. 2. "Off the Beaten Track," by Engineer-Captain E. C. Green, R.N. 7.25 p.m.

OPTICAL SOCIETY.—At the Imperial College of Science and Technology, Imperial Institute-road, South Kensington, S.W. 7. The following papers will be presented and discussed: "The Ross Modification of the Hilger Interferometers for Testing Large Optical Elements," by Mr. O. G. Hay; "The Reflection Factor of Magnesium Oxide," by Mr. J. S. Preston. Exhibitions and demonstrations. 7.30 p.m.

FRIDAY, JANUARY 17TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, S.W. 1. Informal meeting. "The Pooling of Experience—a Function of the Institution?" to be introduced by Mr. Thomas Walley. 7 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Meeting of the South Midland District at Watford. Meet at Watford Junction Station, 11.15 a.m.; proceed to Imperial Works, Balmoral-road, Watford (Penfold Fencing, Ltd.); business meeting of the South Midland District at the works, 12.45 p.m.; lunch at the "Rose and Crown," Watford Market Place; tour of inspection of Messrs. Scammell's Motor Engineering Works, Watford West. 2.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Informal meeting. "London's Water Supply," by Mr. G. Andrew-Marshall. 7.30 p.m.

TUESDAY, JANUARY 21ST.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Graduates' meeting. "Preparation of an Engine for Production," by Mr. L. Hathaway. 7.15 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "Temperature Distribution and Stress Effects in Heating and Cooling of Masses," by Mr. G. Stanfield. 7.30 p.m.

FRIDAY, JANUARY 24TH.

JUNIOR INSTITUTION OF ENGINEERS.—At 39, Victoria-street, S.W. 1. "Refractories for Steam-raising Furnaces," by Mr. W. J. Rees. 7.30 p.m.

TUESDAY, JANUARY 28TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Graduates' visit to the works of Morris Motors, Ltd. (Engines Branch), Gosford-street, Coventry. 8 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, W.C. 2. London Graduates' informal meeting. "Discussion, "Tuning Motor Cycles for Speed," by Mr. S. C. Vince. 7.25 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "Density of Molten Steel," by Mr. B. S. Smith. 7.30 p.m.

WEDNESDAY, JANUARY 29TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Works of the Austin Motor Company, Ltd., Northfield. Graduates' meeting. "The Value of the Institution to its Junior Members," by Professor W. Morgan. A discussion will follow. 7.30 p.m.

WEDNESDAY, FEBRUARY 5TH.

INSTITUTION OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOCIATION.—At the Midland Hotel, Manchester. Annual dinner. 6.30 p.m.

MONDAY TO FRIDAY, FEBRUARY 17TH TO 28TH.

BRITISH INDUSTRIES FAIR.—Olympia and Castle Bromwich, Birmingham.

CONTRACTS.

WILD-BARFIELD ELECTRIC FURNACES, Ltd., Elecfurn Works, North-road, Holloway, London, N. 7, has recently received from manufacturers in this country of steel golf club shafts orders for Wild-Barfield electric furnace equipments for hardening the shafts, similar to those which have been for some time in use for the same purpose in the United States.

BOVING AND CO., Ltd., of 56, Kingsway, London, W.C. 2, have received an order for two 20,400 B.H.P. Francis turbines from Electra de Viesgo, of Santander, Spain. These machines, which are to be of the vertical spiral casing type, are to work under a head varying between 25 m. and 72·5 m. and run at a speed of 250 r.p.m. Owing to the wide variation in head, each turbine will be supplied with two runners, one for the range from 25 m. to 55 m., and one for the range from 45 m. to 72·5 m.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., of London and Chippenham, has received an order for the re-signalling of the Metropolian Railway from Uxbridge to Rayners Lane. The order includes the supply and installation of twenty-two main colour light signals, fog repeater signals, twenty-two electric train stops, fifty condenser fed track circuits, illuminated diagrams, alternating-current relays, lever locks, apparatus cases, cable, line wire, and insulation materials.